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MINISTRY OF AGRICULTURE AND FISHERIES
DEPARTMENT OF AGRICULTURE FOR SCOTLAND
MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND
AND AGRICULTURAL RESEARCH COUNCIL

REPORTS

on the work of

Agricultural Research Institutes

and on certain other agricultural
investigations in the

United Kingdom

1933-1934

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FOREWORD

This volume outlines the progress of agricultural research carried out with the aid of State funds during the Academic Year 1933-34 at Research Institutes and other centres in the United Kingdom. A numbered list of the papers published during the year by each Institute or research centre is appended to each report, and references to the numbers of these papers will be found in the text.

Those desiring further information regarding any subject dealt with in the reports should address their enquires to the Director or other person concerned. A list of the names and addresses of Directors of Research Institutes and persons in charge of investigations at other centres is given in the Appendix (page 336).

Ministry of Agriculture and Fisheries,
10, Whitehall Place,
London, S.W.1.
1936.

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I

RESEARCH INSTITUTE INVESTIGATIONS

SOILS, PLANT NUTRITION AND PLANT PHYSIOLOGY

1. ROTHAMSTED EXPERIMENTAL STATION

Crop Production.

Leguminous crops.—The results of inoculation of lucerne seed with its proper nodule organism before sowing have proved so successful that the process is now very widely adopted : the sales correspond to about 4,000 acres of lucerne per annum. The arrangements for preparation and distribution of the cultures continue to work very satisfactorily : samples are regularly sent to our laboratory for testing and are invariably found to be efficient.

The work has now been extended to clover, and field trials have been started in conjunction with the Welsh Plant Breeding Station on the Welsh hill pastures. The laboratory experiments at Rothamsted, however, revealed an unexpected difficulty and showed the presence in the soils of a range of strains of the clover organism capable of infecting the clover, some of which are highly efficient but others, so far from being beneficial, are actually harmful to the plant.

Among the various strains examined two have been found which not only promote the growth of the clover well but are also able to some extent to overcome the harmful effect of the less efficient or injurious strains. The possibility of this kind of action having been established, a careful search among other strains is being made in the hope of finding some that are sufficiently good to justify large scale trials.

This work holds out considerable promise of application in the laying down of temporary and permanent grass.

Non-leguminous crops.—Field experiments on all the most important agricultural crops are made at Rothamsted and Woburn using the new methods devised by the Station, which involve detailed physiological studies. A simplified form of the experiment is repeated at outside centres in association with county organisers, the staffs of the Colleges and Farm Institutes, and schools.

A further advance in the design was made two years ago, and has enabled us to simplify the procedure and to obtain a great amount of information both as to the direct actions and the interactions of nitrogenous, potassic and phosphatic fertilisers.

A number of experiments on these new lines have been made in connection with the Sugar Beet, Basic Slag, and Poultry Manure Committees set up by or acting under the aegis of the Ministry of Agriculture. For the first time information has been obtained of known degree of trustworthiness in regard to the manurial responses of crops grown on commercial farms under ordinary good methods of management.

Experiments on the manuring of sugar beet have been made for several years both at Rothamsted and Woburn but the results have never accorded with expectation, there being much less response to fertilisers than was expected. In 1933 a preliminary set of field trials was made by aid of a grant from the sugar beet factories on a number of farms selected by their agricultural officers but again the responses were very small. The yields however were all above the average and it was supposed that the land was probably in too high a state of fertility.

The advice given to farmers is not based on any critical experiments made in this country but on general Continental experience. Owing to the great differences in soil and climate it is unsafe to transfer Continental experience direct to this country especially when it clashes with results of experiment: at the same time the number of experiments was too small to justify us in recommending farmers to break away from the advice given them. In 1934 a more extended set of field trials was made, again at centres selected as typical of their regions by the factory agricultural officers.

Simultaneously numerous chemical examinations of the soils have been made with the view of finding what connections exist between chemical composition and response to fertilisers, and if possible of devising or adapting some method of analysis that would enable the chemists to forecast with reasonable certainty the response to the fertiliser.

Again the response to manures was unexpectedly small. The "general manure" so often recommended was generally unnecessary. At about half the centres nitrogenous manure gave profitable increases; at a few centres phosphate was effective, though not at others, so that its average effect was only to give an additional 5 cwt. per acre of roots: while potash gave no increase in roots and only an average increase of one quarter of one per cent. of sugar.

Both 1933 and 1934 were unusually dry and sunny and this may account for the lack of fertiliser response: in spite of attempts to find typical centres the yields were still above the average, as no doubt were the farmers on whose land the work was done. It is hoped that the work can be continued until the manurial problems are satisfactorily settled and the relation between response to fertilisers and composition of the soil is better understood.

Investigations have been commenced to discover the part played by the subsoil in the growth of the sugar beet. It was shown that at Woburn the crop was taking water from a depth of four feet, and the time was estimated within a few days when each successive foot of the soil was drawn upon.

The potato experiments carried out at Rothamsted, Woburn and outside centres during the past few years were worked up and the results discussed at a conference of potato growers held at Rothamsted in February, 1934.

For some of our fertiliser investigations, e.g., those on poultry manure, market garden crops constitute much better material than ordinary agricultural crops and consequently a certain number of trials are made in Bedfordshire and other vegetable growing areas. These are giving us useful information on the effects of fertilisers on these important crops.

In the course of these various experiments much information has been gathered in regard to the management of light land. This was discussed at a conference of farmers and agricultural experts in March, 1934.

In regard to grassland the basic slag experiments have shown that the relative effectiveness of the different slags varies according to their solubility in the standard citric acid solution but the actual effectiveness of the least soluble slag varies according to local conditions which cannot yet be defined. Low soluble slag had given some strikingly successful results in Scotland and has failed altogether in parts of England but whether the difference is due to soil or climate cannot yet be decided.

Mineral phosphate did not fit in with the slag series, and in spite of its relatively low solubility was in some instances nearly as effective as the best slag : in other cases it was ineffective. It gave good results on acid soils in wet districts but more information is being obtained to decide the conditions.

Hitherto the experiments have been made on arable land or on repeatedly mown grass : attempts are being made to design trustworthy grazing tests.

The new methods of field experiments are being applied to assess the value of poultry manure. In general it has proved inferior to artificial fertiliser in immediate effect, but some estimate of its residual value is being sought.

The method of pot culture has been modified in various ways during the last few years and in consequence the average results are in fairly close agreement with those of field experiments.

Minor elements in plant nutrition.—Manganese is needed by plants, though only in small amounts; in its absence they become liable to certain diseases such as grey speck disease of oats. Chemical examination shows that the determining soil factor is not the actual amount of manganese present, but the proportion that exists in the exchangeable form and the tenacity with which it is held. Molybdenum salts when injected into plants have been found to cause symptoms that look very much like those of virus disease. This observation is being followed up. It has been shown at East Malling that some fruit tree stocks can take up molybdenum from the soil and others cannot.

Composition and quality of crops.—Increasing attention is being devoted to the difficult problem of quality of crops, the general procedure being to work in association with the expert users and buyers, carrying the work up to the stage where it is more appropriately continued by them. During the past twelve years investigations have been made into the quality of malting barley. The work began at the agricultural end and developed towards malting and brewing problems. A miniature brewing plant was erected so that the barley samples could be studied from the field to the brewer. The work proved so successful that considerable expansion became necessary and at this stage it was deemed better to transfer it to the School of Brewing, Birmingham, where malting and brewing investigations are more appropriately made : this was done in April, 1934. In October, 1934, a conference was held at Rothamsted between the barley growers and the buyers at which some 200 samples of malting barley were exhibited and discussed. The interchange of opinions and of observations proved so useful that a further conference will be held in October, 1935, and if thought desirable this will become an annual event.

Work on the quality of wheat is carried out in association with the Millers' Research Institute, St. Albans. Certain physical properties of dough are so closely allied to the properties of clay that they are studied at Rothamsted, but the workers are in constant communication with those at St. Albans.

The investigations on the quality of potatoes begun in 1929 have now been transferred almost entirely to the laboratories of the firm associated with the Station in this work, but a few key determinations continue to be made here so as to facilitate linking up with their work.

The quality of green fodder crops has been for some time under preliminary investigation and now that the barley investigations have been transferred it will be further studied. The work is based on the fact that a green fodder plant passes through two stages in its life history ; in the first stage it is assimilating nitrogen and mineral matter from the soil and is consequently rich in protein equivalent and minerals : in the second stage it is elaborating carbohydrate, sugar, starch, cellulose, lignin etc., and is consequently rich in starch equivalent and fibre. The work promises important practical application in two directions. The fibre industry in this country is rapidly developing in consequence of the growing demand for artificial silk and other materials. A Textile Physics Department, which has been set up at Leeds, has made X-ray photographs and various examinations of preparations made by the Station. Some interesting results are promised.

The other practical application is to animal nutrition. Studies of "crude fibre" have shown its relation to the cell wall constituents. It is recognised, however, that chemical investigations alone will not satisfactorily deal with quality of fodder crops, since biochemistry is not yet sufficiently advanced to give complete indications of the feeding quality of the various crops; methods have therefore been developed for using pigs for this purpose, adopting weight, grade and bacon factory reports as the criteria. The work is now reaching a stage where plant nutrition begins to approach animal nutrition, and it is proposed to invite the investigators in animal nutrition to confer with us so as to ensure the fullest return for the labour expended.

Soil cultivation.—The experiments on soil cultivation carried out for several years in succession indicate that little if anything more is necessary than to prepare a good seed bed and stop the growth of weeds. Frequent stirrings and intensive cultivation have not infrequently done actual harm. Moreover rotary tillage which prepares the seed bed in one operation is usually (though not always) as effective as the ordinary methods which require two or three operations and are therefore considerably more expensive. A new experiment was started last year to test the effect of these reduced cultivations over a period of years.

Composition and physical properties of the soil.—Progress continues to be made with the difficult problems associated with composition and physical properties of soil, especially of the clay fraction, which is recognised as the dominating constituent. Among the properties studied are the relations to plant food constituents, and to water, the formation of tilth and of crumbs.

MICROBIOLOGY.

Further measurements have been taken showing the remarkable and continuous fluctuations in numbers of the bacteria in the soil; these occur not only in the field, where they might be attributed to complex interactions of temperature and moisture supply, but even when the soil is kept in constant temperature and moisture conditions in an incubator. Further, they occur when only a single species is present, so that they cannot be attributed entirely to interactions between organisms. The possibility that they may have to do with reproduction cycles is being investigated.

Some observations have shown that a kind of antagonism exists between certain groups of soil fungi so that one cannot develop when the other is present. This suggests possibilities of controlling pathogenic soil fungi that will be further studied. Meanwhile an interesting side line has been opened up: some of the actinomycetes picked out from the soil have the power of making fragrant substances. As the subject is hardly one which concerns the Station it is being studied by a well-known manufacturer of scents and perfumes. This same expert found among the by-products of the milk effluent investigation described below a substance which we had been seeking to destroy but which he regards as of considerable potential value as a means of enhancing scents: a rather unexpected discovery.

The practical application of soil microbiology to the making of artificial farmyard manure has been continued. This makes steady progress, and the Adco syndicate put into large scale practice the results obtained. New possibilities continue to open up. French workers have recently developed a side which has not as yet been considered in England: the making of artificial farmyard manure for the sake of the heat generated during the process, this heat being used for the forcing of early vegetables.

Considerable effort is devoted to investigations of methods of purifying effluents from milk factories, the work being somewhat on the lines adopted for treating effluents from sugar beet factories. Hitherto the fat always present in the effluent has constituted an almost insuperable difficulty : a method is now devised for decomposing the fat by treatment in a septic tank either aerobically or anaerobically, and then passing the effluent over percolating filters.

PLANT PATHOLOGY.

A new programme of investigation into fungus diseases has been worked out, and is now in progress.

It has been shown that the inoculation of tomatoes with a certain strain of the virus producing mild symptoms of yellow mosaic protects the plant against invasion by a more virulent strain of the same disease virus. All strains do not interact in the same way, however : a virus already present in the plant instead if preventing invasions by another virus, may simply prevent the appearance of the symptoms while still allowing the virus to enter and to multiply within the plant. Or again the two viruses may induce a more severe form of the disease, or produce a different set of symptoms from either separately: finally the two viruses may simply act each in its characteristic way without interfering one with the other.

ENTOMOLOGY.

The work of 1934 was mainly concerned with studies of the factors determining the fluctuations and migrations of insect populations. It involves taking frequent and systematic censuses of the populations of insects concerned, and methods of doing this have been worked out. The results are then correlated with climatic factors, and, for the night flying insects, with moon light and cloudiness of the sky : of all these, temperature appears to be the most important. Work on gall midges and observations on the ovipositional and feeding reactions of the sawfly *Pteronidea melanaspis* have been continued.

The investigations on bees continue to attract the attention of practical beekeepers. Last year an investigation of brood diseases of bees was carried out. The Lister Institute of Preventive Medicine is kindly allowing the Station the use of their laboratories for the serological and other investigations, thereby saving considerable reduplication of costly equipment and ensuring adequate control on the bacteriological side. A very successful conference with practical beekeepers was held in May, 1934, in which their experience was freely set out for the benefit of the investigators.

INSECTICIDES.

The method of chemical evaluation of samples of pyrethrum has been further improved, and a parallel investigation on derris has been commenced. The results so far obtained have attracted wide interest.

The work on soil insecticides and fumigants which has been in abeyance for a few years has now been resumed.

FARM HUSBANDRY.

As far as is practicable without detriment to the scientific work investigations are made at the farm on matters of practical husbandry. In 1934 a series of measurements was made to find the number of units of electricity required to do definite amounts of work about the farm buildings, and the number of gallons of liquid fuel required to do the work when the source of power is an oil engine or a tractor. The Oxford Institute of Agricultural Engineering is giving valuable help and advice.

The farm staff is as interested in experimental work as the scientific staff. The sheep husbandry experiments are of considerable promise; they have dealt with the flushing of the ewes and other items of management. The four-teated ewe flock is increasing, and is run with the two-teated flock so that the lambs may be otherwise comparable: detailed records are kept of the rates of growth of the lambs to see if the additional teats tend to increase the milk supply.

Titles of papers issued during the year.

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6. Keen, B. A.: Physical measurements of soil in relation to soil type and fertility. *Empire Cotton Growing Corporation Conf.*, 1-7, July, 1934.
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22. ———: Fires adjoining railway lines: a useful preventive. *Modern Transport*, **31**, 793, 9, 1934.
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2. MACAULAY INSTITUTE FOR SOIL RESEARCH, ABERDEEN

Soil Classification and Surveys.

The study of the soil types found in Scotland has been continued in various parts of the country. For certain areas these types have been studied morphologically in the field, and chemically in the laboratory; for others, in addition, mapping has been carried out, and the scale of this mapping has been varied to suit the circumstances.

(i) *Eastern part of Kincardineshire.*—The field study of the soils of this area has been continued. Descriptions of representative profiles and samples of these have been collected; striking differences in types, according to the parent materials, have been found. A further study of these is to be made in the laboratory.

(ii) *Durris, Kincardineshire.*—The soil survey of the woodland on the Durris Estate, near Aberdeen, has been completed, and the chemical and mechanical analyses of the principal types is now in hand.

(iii) *Teindland, Morayshire.*—The work on the soils of the Teindland Forest was completed, and a report published (3).

(iv) *North-west and Central Highlands.*—During the summer of 1934 a number of areas in the N.W. and Central Highlands have been visited and preliminary surveys made. These areas include the following: Achnashellach, Braemore, Inchnacardoch—all on Moine schists; Clashendarroch, on slates and andalusite schists; Glen Righ, on slates and quartzite; Drummond Hill on garnetiferous biotite-schists; and Inverliver on epidiorite and Loch Awe grits. Analyses of representative soils show that the predominating process in soil formation is podzolisation, but gleyed soils are very common. The effect of slope on the soils in all cases has been found to be marked, in some instances almost obliterating the podzolisation process. The epidiorites on Loch Awe side, under oak and recently planted conifers, seem to give rise to a soil of the " brown earth " type, but it is not quite clear to what extent the slope on which these soils occur has influenced their development.

The chemical and mechanical analyses of these soils are now in hand.

(v) *Aberdeenshire.*—The setting-up of an electricity transmission line from Kintore to Keith, Aberdeenshire, has offered the opportunity of obtaining a fine section across the county. The underlying rocks include horneblende schists, granite, diorite and slates, and work on the line is being followed up so as to obtain as complete a collection of the soils as possible. An attempt will be made to survey as much of the line on the 6 in. scale as time will allow.

(vi) *Areas in Renfrewshire.*—One or two areas are being surveyed on the scale of 6 in. to the mile.

Study of the "brown soils" found in Scotland.—A series of investigations has been in progress since October on profiles representative of brown soil types occurring in Scotland. Both cultivated and uncultivated soils are included. Among the principal analyses being carried out are pH and exchangeable cation determinations, and clay fraction, oxalate extract and mechanical analyses. The results so obtained are being compared with those from other investigations in order to classify the soils and find their relation to the Continental Brown Earths. The results, as yet incomplete, show that it will probably be possible to fit the Scottish soils into one or other of the European groups previously described.

Geological Work.

In the study of the mineral content of soils of north-east Scotland, special attention has been paid to Eastern Kincardineshire. Here the main type of parent material is boulder clay, and this has been examined over the area. There are three types—two of these indicate that the ice traversed the region from the north-west, travelling over an area of igneous and metamorphic rocks, and incorporating much of that material. The other came from the south-west and traversed a region mainly of sedimentary but also of igneous rocks. These clays differ in colour, and have now been found to differ in mineral content, except in the areas where overlaps occur. In all the clays examined, the minerals are very fresh, and there is a high proportion of ferro-magnesian silicates, contributed from the igneous and metamorphic rocks. This variation in mineralogy is found reflected in the soils. The soils of other areas have also been examined, and also materials collected by other workers.

Soil Fertility.

Field experiments.—During the season 1934 a series of field experiments, similar to that carried out in 1933, was laid down in order to verify the previous year's results, and also to obtain further correlation with pot culture experiments and laboratory investigations. A description of the field method for the determination of manurial requirement of soils has been published (1). This method was used during 1933, but in 1934 it was decided to modify the procedure. The plots were made larger and marginal strips rejected during harvesting. In addition, the treatments were randomised.

The soils investigated during 1934 (34 soils) were spread over a wide area, and were drawn from different types of parent material, including calcareous soils in East Lothian, shales in West Lothian, carse clays in Stirlingshire, Old Red Sandstones, granites and peaty soils in Kincardineshire, Aberdeenshire and Morayshire.

Pot experiments.—A number of the above soils were selected and examined by the Mitscherlich method. The results of similar experiments in 1933 indicated that the field test gave much higher values for phosphoric acid content than did the pot experiment, and it is believed that the difference is caused by the high nutrient content of the subsoil. These results have been verified during 1934, and an account of the work is about to be published.

In conjunction with the Rowett Institute, a series of pot experiments with grasses was undertaken to find the effect on the chemical constitution of the plant of adding copper and iron salts to the soil.

A series of forest soils was investigated in conjunction with the Forestry Department by the Mitscherlich method, using Scots pine seedlings as the indicator plant, to see if this method could be applied to forest plants.

Laboratory investigations.—Laboratory determinations are being made on samples of the soils examined in the field and pot experiments, with a view to checking the methods at present used in routine advisory work. As a result, modifications in the latter have been introduced, including an acetic acid extraction for potash. With soils rich in organic matter or iron a similar extraction has been worked out for phosphoric acid.

Uniformity trial.—The uniformity field trial was continued, the crop being oats. The statistical treatment of the results has been undertaken by Dr. Tocher. As a result of his analyses, soil samples have been taken to find if correlation exists between irregularities in yield and soil properties.

Slag experiments on turnips.—In conjunction with the Permanent Committee for Basic Slag, experiments have been laid down at three centres in the north of Scotland. Various phosphatic manures were applied, and the crop is now ready for harvesting. Soil samples from the various plots are being tested in the laboratory.

Joint work with the North of Scotland College of Agriculture.—As mentioned in last year's report, a number of soil samples were taken from a series of field plots at Craibstone, where 6-course rotation experiments with lime and with various artificial fertilisers are being conducted. The analytical results obtained with these samples serve as a preliminary characterisation of the experimental areas. Further samples have been taken for analysis, with a view to studying the changes produced in the soil in relation to the treatments applied and the yields obtained.

Forest nursery soils.—With a view to obtaining information on the amounts of phosphoric acid, potash and organic matter necessary to constitute a reasonably fertile nursery soil, experiments have been laid down in conjunction with the Forestry Commission on four nurseries. From the results of preliminary analyses various treatments were drawn up with a view to obtaining three grades of fertility in each nursery. These treatments were applied to a soiling crop in 1934 in areas which are to be under forest seedlings in 1935 and 1936. Soil samples will be taken from time to time, and at the end of the experiment samples of the plants will also be taken for analysis. The results of soil and plant analyses are to be compared, and it is hoped to correlate these results with the assessment of the growth of species as made by the Forestry Commission.

The Study of Peat Soils.

Macaulay Demonstration Farm, Lewis.—Experimental work at the farm had again to be curtailed owing to lack of funds, but it was found possible to continue a drainage experiment and to carry out a few simple pasture improvement trials. There is need for more drainage and better roads on the farm.

Additional areas of moorland are being converted into good pasture, and in most cases this is done without cultivation. In addition to the dairy herd, sheep are now kept on the farm. The excellence of the pasture which has been established on this wet and barren moorland has been commented on by all visitors, and the influence of the farm is being felt throughout the island. The importation of considerable quantities of milk into Lewis has now practically ceased, and here and there crofters are reclaiming land with the aid of implements lent by the Demonstration Farm. A paper was presented at the Third International Fertilisers Conference at Berne (6) giving some account of the problems of improving the poorer classes of land in Scotland, and accounts of moorland reclamation have also been published (5, 7).

Laboratory and survey work on peat.—Advisory work on peat soils and peat products has been undertaken. It was observed that peat soils did not give satisfactory results when examined by the methods used with mineral soils, and a number of modifications have had to be applied. The field experiments already described were used as a means of correlation, and a number of peaty soils were investigated.

On the survey side it is hoped to be able to draw up a general classification of the peat deposits. Chemical analyses of a number of samples are being undertaken.

The method for the estimation of carbon which has been worked out and tested at the Institute has been submitted for publication. It has been found to be both accurate and rapid when used with pure substances and with soils.

Special Investigations.

Soil organic matter.—Two widely different systems proposed for the proximate analysis of organic matter in the soil profile, viz., Waksman's and Grosskopf's, have been compared. Some typical soil profiles from the north-east of Scotland have been used in the investigation, and the determinations made include carbon, nitrogen, ether-, alcohol-, and water-soluble fractions, hemicelluloses, cellulose, lignin and humus.

Lawn experiment.—The lawn treatments carried out during the past two years continue to show marked differences. A botanical examination is to be undertaken in the early spring, after which an account of the investigation will be published.

Pasture experiments.—The pasture investigations undertaken jointly with the Edinburgh and East of Scotland College of Agriculture have been continued, and at present the soil nutrient factor in relation to pasture reversion is being studied.

Forest soils.—The work which has been going on for the past two years at Craibstone and Durris on forest soils in order to study certain factors associated with differences in tree growth has been discontinued.

Craibstone Lysimeters (4).

The study of the composition of the drainage from the soil of the Craibstone lysimeters has been continued. In 1933 the lysimeters were cropped with potatoes for the first time, and during 1934 the crop was Victory oats. Lysimeter No. 1 was as usual unmanured, while Nos. 2 and 3 each received sulphate of ammonia, 1 cwt. per acre, superphosphate 2 cwt. per acre, and 30 per cent. potash manure salts, 2 cwt. per acre. The oats were sown and the manures applied on 9th March, 1934. Considerable damage was done to the young plants by wire worm, and all three plots were somewhat thin; a second sowing was made on 21st April, but in spite of this all three plots were rather patchy. During the early growing period rainfall was considerably above the average, with snow in April, while in June and July it was below the average, with another considerable excess in August. The crop was harvested on 11th September, and owing to the thinness the yields were somewhat low. Separate ash analyses of the grain, straw and chaff are being carried out. The composition of the drainage waters was determined monthly.

As pointed out in previous reports very fine colloidal suspended material appears occasionally in the drainage waters in varying amounts. This material is being separated by different methods and analysed.

In preparation for the turnip crop to be grown in 1935 ground lime at the rate of 2 tons carbonate of lime per acre was applied to Lysimeter No. 3 when the plots were dug over at the end of October, 1934.

Titles of papers issued during the year.

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3. CHEMICAL (AND ANIMAL NUTRITION) DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

Soils and Fertilizers.

Methods for the determination of manurial requirements.—The examination of soils for manurial requirement by the Mitscherlich method has been continued. Out of twenty-six soils which have been tested only three appeared to be adequately supplied with phosphate. Manurial trials in the field based on the results of the Mitscherlich test, showed that in about two cases out of three the method had given reasonably correct forecasts of the response to fertilisers.

Lime requirement and soil acidity.—Data from many field experiments on the response of the soils of Northern Ireland to lime are still being collected. The effect of lime is generally best seen in the case of first crop hay but in the case of other crops the response is generally small.

4. RESEARCH INSTITUTE OF PLANT PHYSIOLOGY, IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Effects of mineral deficiency on barley.—The analysis of the effects of phosphorus starvation has been carried further. In the summer of 1933 the respiration rates of successive leaves from plants deficient in phosphorus were investigated. Four levels of phosphorus nutrition were employed, one as control with ample supply, the others with $\frac{1}{3}$, $\frac{1}{9}$, and $\frac{1}{81}$ of this standard amount. The potassium level was varied similarly and various combinations of phosphorus and potassium deficiencies were thus secured. At the same time material was collected for determination of certain nitrogen and carbohydrate fractions in the leaves.

In addition the problem has been approached by a preliminary series of feeding experiments. Leaves from normal and deficient plants were fed with various solutions and the effects on respiration studied. The substances given included potassium salts, phosphate, sugars and amino acids. The experiments have demonstrated that potassium plays no direct part in respiration; the increase associated with potassium deficiency is secondary. It is probable that unusually high amino acid and phosphorus content are concerned. Phosphorus-deficient leaves immediately respond to feeding with phosphate, and the low respiration found with such leaves must be due largely to lack of phosphorus. At the same time the protein content is concerned at all levels of phosphorus manuring. Direct estimations of assimilation rate of successive leaves of both phosphorus- and potassium-deficient plants in air of normal carbon dioxide content has been carried out. A considerable reduction rate was found with medium deficiency ($\frac{1}{9}$) of phosphorus and low assimilation rate was found with the lowest level of supply ($\frac{1}{81}$). In potassium-starved plants, assimilation fell with successive leaves, reaching a very low minimum, and finally showed recovery. The control plants gave results similar to those previously reported; even higher rates of assimilation were obtained with more rapid air flow. Direct assimilation determinations by the new method employed agree with previous findings by growth analysis and laboratory studies with air enriched with carbon dioxide.

Water content and mineral deficiency.—Further work has been carried out on the relation between the water content of potassium-starved plants and the other nutrients present. Marked changes in the symptons of potassium starvation were also noted.

With a high level of phosphorus the colour of the leaf is generally darker green than with higher calcium. At a low phosphorus level the purple colouration due to phosphorus deficiency masks completely the symptons of potassium starvation; the purple colour increases with calcium level. With high sodium and low calcium the usual pale green colour of the leaves marks the potassium deficiency; with high calcium and low sodium white patches on otherwise green leaves are the symptons of potassium deficiency.

The tiller production showed a complex relationship to manuring. With complete potassium deficiency the tiller number shows a marked optimum at medium calcium level. The effect of sodium is nil at medium calcium level; at high calcium level a large increase in tiller number is obtained by sodium addition. The same type of results was obtained at high and low phosphorus levels; though with low phosphorus the general level of tiller numbers was reduced.

With high calcium, without sodium, the water content decreases with potassium deficiency. With medium or low calcium, and high or medium sodium, water content increases with potassium deficiency. These statements hold only with high phosphorus level, low phosphorus invariably leads to low water content.

After effects of temperature on winter cereals.—The behaviour of hybrids of spring and winter varieties is being studied. The spring habit is completely dominant. The F_2 generation will be grown this year. The effects of high night temperatures are being investigated, and also the effect of low temperature treatment on embryos separated from the seed. There is some evidence that the specific effect of low temperature acts through the endosperm.

Control of transpiration.—A description of the new porometer is now published (4). Simultaneous estimations of transpiration rate, water uptake, water content and stomatal aperture have been made under controlled conditions. It has been shown that for a given stomatal aperture the transpiration rate depends on the water content of the leaf. If the water content of the leaf falls as a result of cutting off the water supply, stomatal movement lags behind transpiration, so that a low level of transpiration may occur with wide open stomata. If now the water supply is renewed the water content rises very rapidly to the maximum, meanwhile stomatal closure takes place with a steady transpiration rate. Finally transpiration again rises very considerably before stomatal opening begins and the original condition of the leaf is resumed.

Assimilation.—A study of the relation between stomatal aperture and assimilation rate is now in progress. A new apparatus for estimation of carbon dioxide has been devised, of which a description is in the press.

A study has also been made of the relation between the respiration rate immediately following a period of assimilation and the respiration rate of a normal period. Under some conditions a considerable increase in respiration results.

Electroculture.—An experiment including 312 pots was carried out in 1933, Plumage Archer barley being employed. Portable, transparent shelters were used to protect the plants from heavy rain which might cause loss of nitrate. The water content of the pots was controlled by weighing. Attention was again directed to the time of the period of discharge and the effect of negative as against positive discharges. The effect of two types of discharge on a "detillered" plant bearing only a single ear (that of the main axis) was also studied. The results indicate a very definite effect of direction of current, the negative discharge having an inhibitory effect on development and grain yield. Similar but less marked results were obtained with detillered plants. This result suggests that the current has some effect on the conduction of materials in the plant. The early period of electrification (five-leaf stage) has had the most marked effect; but treatment either at this or the twelve-leaf stage has increased the number of ears and also the total number (sterile plus fertile) of flowers. The positive discharge gave no reduction in the percentage of sterile flowers but the negative treatment (E 1 —)

raised the sterility to 47 per cent. above the controls. In June, 1933, J. O. Musso, of Leningrad, published the results of some experiments in which the electrical field in the neighbourhood of the plant was increased by the use of low voltages (10-180 volts). With such treatment increases of 33 per cent. were described. The experiments were therefore repeated using white mustard but no significant differences were obtained.

Temperature and root absorption.—Experiments have been made on the effect of external conditions on the rate of absorption of mineral elements by the roots of barley. It has been shown that if the aerial parts are kept under constant conditions, change of temperature of the roots has little effect on absorption.

Light and rate of growth.—The rate of growth and the assimilation of *Lemna* have been studied at various temperatures and light intensities. It has been demonstrated that apart from its action an assimilation light has a controlling effect on growth for with rising light intensity the multiplication rate of *Lemna* will increase without any increase in the assimilation rate.

Physiology of tomato seedlings.—The effect of light and temperature on assimilation of tomato seedlings (variety E.S.1) at the eight-leaf stage, have been investigated over the range found under the usual cultural conditions and the relationship shown in the form of a surface. During the winter months, November to March, assimilation is limited by the low light intensity while during the summer months, June, July and August, light intensity is often supraoptimal. In winter the water content of the leaf is frequently so high as to bring down the level of the assimilation rate; in summer, however, it is often suboptimal. Work on the translocation of assimilates from the leaf into the stem suggests that as a rule the amount of carbohydrate translocated during the assimilation period is proportional to the assimilation rate but that other factors may under certain circumstances profoundly modify this relationship. Thus moderate and high light intensities tend to reduce translocation; while in very low light intensities translocation rises to a level which may inhibit leaf development.

Methods for investigating the relationship between leaf-expansion and other factors, in particular those factors affecting water uptake have been evolved and it has been shown that a close correlation exists between the amount of water a young leaf can take up when detached from the plant and the amount of expansion that the leaf would normally undergo during the night.

The effect of light and temperature on the permeability of the leaf tissue to certain ions has been investigated and the permeability has been shown to rise with temperature over a considerable range; a slight rise with light is also exhibited.

Sugar beet investigation.—In co-operation with Rothamsted Experimental Station a physiological study has been begun of sugar beet and mangel. Both plants have been sown at a number of different dates and their physiological life history followed throughout the season by a study of fresh weight, dry weight, total leaf area, etc. Samples of roots have also been obtained and the sugars in these are being estimated.

Titles of papers issued during the year.

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3. Ernest, E. C. M.: Studies in the suction pressure of plant cells. II. *Ann. Bot.*, **48**, 293-305, 1934.
4. Gregory, F. G., and Pearse, H. L.: The resistance porometer and its application to the study of stomatal movement. *Proc. Roy. Soc. B.*, **114**, (790), 477-493, 1934.
5. Groom, P., and Panisset, T. E.: Studies on *Penicillium chrysogenum* in relation to temperature and relative humidity of the air. *Ann. Appl. Biol.*, **20**, 633-660, 1933.
6. Hicks, P. A.: Interaction of factors in the growth of *Lemna.* V. Some preliminary observations upon the interaction of temperature and light on the growth of *Lemna. Ann. Bot.*, **48**, 515-525, 1934.
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B

PLANT BREEDING, CROP VARIETIES AND SEEDS

5. PLANT BREEDING INSTITUTE, CAMBRIDGE UNIVERSITY

Cereal rusts.—The past season, like that of 1933, was characterised by an extraordinary scarcity of rusts. The particularly susceptible variety always planted at intervals throughout the plots as an inoculator became well infected in the early spring, but the rust failed to spread naturally and all attempts to start up an epidemic artificially failed. As a result no data with regard to rust susceptibility in the open are available for a rather extensive series of wheat hybrids at the F_2, F_3 and F_4 stages. The F_3s of the 1933 harvest were, however, tested under glass during the winter months and the seedling reaction determined for some 200 forms. It is being assumed for the time being that seedling and adult plant reactions to *Puccinia glumarum* are identical, but a final proof of this will not be obtained until a normal rust epidemic occurs.

The lack of rust cut out one of the most important features on which selection is made in the F_2 and F_3 generations with the result that it was necessary in both years to harvest an unduly large number of individual plants. Their examination and growing on taxed the resources of the Institute severely in 1934 and it is doubtful whether the whole of the material can be grown on in the coming year.

Mr. Dickinson, University Lecturer in Plant Pathology, has been working in association with the Director on the causes of immunity and susceptibility to *P. glumarum* and *P. triticina* and has opened up several promising lines of enquiry. The Institute also provided facilities to Dr. K. Neatby of the Dominion Rust Laboratory, Winnipeg, to investigate the susceptibility to yellow and brown rusts and to mildew of a long series of new forms whose reactions to the black or stem rust had been determined in Canada. A useful start on the genetic relationship between resistance to different diseases was made and evidence obtained that reactions to distinct diseases may be correlated in inheritance.

Mildew.—A severe epidemic provided an opportunity for grading all of the F_3 and subsequent generations of wheat hybrids. Their reactions are to be compared with the reactions to yellow rust as soon as a complete set of comparable data exist for this fungus.

Cases were again observed of susceptibility far transcending that of the parents, but only amongst species hybrids.

Shattering.—This feature is normally of little importance to wheat growers in this country. But attention has had to be paid to it because one of the most useful parent wheats we have is marred by this defect. Crosses with this wheat have produced the highest yielding hybrids yet raised mainly because the spikelets carry a larger number of grains than usual. But during the dry seasons of 1933 and 1934 the wastage through shattering was so great that it has been decided to abandon their further cultivation. The shattering is due to the shortness and softness of the glumes, which, when forced back by the grains, break readily at the base. The feature shows a normal Mendelian inheritance with a partial linkage between " many grains " and " short glumes ". The combination many grains and normal glumes has been secured, and as some of the F_3s appear to be homozygous, yield trials will be possible in a year or two.

Straw characters.—The weather conditions were unfavourable for testing the standing capacity of the straw, for at harvest time both the weakest strawed and the intensively manured cultures were upright. Cultures breeding true to a straw length of 2 feet 6 inches were obtained. As they appear to be fixed in other respects they are to be grown on immediately for field trials. A series of single plants was, however, taken out for a detailed examination of their grain characters.

Wheat quality.—An attempt to grade F_2 and F_3 generations more finely for quality was started in 1933 and continued in 1934. So far it seems clear that the soft, starchy character is a clean cut recessive. The genetics of the mottled type, in which the grain is translucent and starchy in patches, is obscure. The majority give a mixed offspring : this and the percentage present in the F_2 generation suggest that mottled is the heterozygote of starchy and translucent, but there are too many cases of mottled forms giving a wholly starchy offspring for this simple explanation to be accepted. Further, the extracted translucents do not form a homogenous group, for a large percentage of them throw mottled and starchy grain.

Yield trials.—The usual Latin square series of yield trials was grown. The data still have to be examined, but the obviously erratic effects of the drought suggest that they may be of little value.

Potatoes.—A collection of South American wild and cultivated forms was obtained and a study of their characteristics made as a preliminary to an attempt to raise " blight " resistant forms.

Barley.—Ten selections from the yield trials in 1933 were tested again in Latin squares in 1934. The trials were in some ways unsatisfactory owing to bird damage resulting in approximately

50 per cent. loss of plants in most plots. Calculated results show that plant number has had no effect on yield, however, and the accuracy of the experiments appears unimpaired statistically. One of the selections again yielded statistically higher than the standard, and several others were of equal yielding capacity.

Selections were made from an autumn sowing of a six-row cross (49 α and 49 β) on the basis of winter hardiness, standing ability, earing time, and yield promise.

An attempt was made to analyse the inheritance of time of earing in several F_3 generation hybrids. The scheme was to test the homozygosity or heterozygosity of the F_2 plants by taking the earing time of each plant's progeny. These results have not yet been worked out.

The sowing of the F_2 of an early barley crossed with a late barley, at different times in the spring, showed that the late sowing offered a useful method of separating the genotypes which was impossible in the early sowing.

Crosses between two Continental winter-hardy, high-yielding, two-row barleys and the best malting barleys of this country were made in 1933. The F_1 generation has shown an almost complete dominance of the large ears, stiff straw, and winter habit of the Continental forms.

A series of crosses made in 1933 to investigate the inheritance of the palea appendage has given interesting results in the F_1, particularly in relation to the characters of awnless and hoodedness, where the F_1 showed short awn development.

F_3 analysis of various crosses made to study the inheritance of fertility of the lateral floret has resulted in some interesting enlightenment on the differential behaviour of heterozygotes which have previously been lumped together in one class by most investigators.

In 1931 an extensive series of crosses between six-row barleys and the best of our two-row malting barleys was made. The object of these crosses was to extract six-row malting barleys. In 1934 only the F_2 segregates were harvested for growing on and further study.

Preliminary experiments were conducted on the reaction of some cereal varieties to Lyssenko's low temperature grain pretreatment. The results show that this low temperature treatment can stimulate the early growth of wheat, barley and oats, and can accelerate the earing time of winter varieties of wheat and barley by as much as 14 days.

The series of Spratt-Archer selections made four years ago was repeated this season : five selections were subjected to a quantitative yield test similar to that carried out last year. It is questionable, however, whether the results obtained under such severe conditions of drought furnish reliable data. Some of the F_2 generation of various hybrids obtained in 1933 were carried into F_3 in 1934. Special attention was devoted to the narrow-eared forms of Spratt-Archer × Spratt, of which 1,080 selections were sown; in addition, a few special forms from other crosses were sown, but the bulk of the produce of the F_2 material remains to be dealt with as time and opportunity permit in future seasons.

Oats.—The work with oats this season consisted largely of quantitative tests conducted in small plots arranged in the Latin square system of random distribution. Included in the tests as one series of comparisons were Resistance and other winter-hardy derivatives of Argentine × Grey Winter and the parent Grey Winter itself; in a second series 6 selections of a series denominated "ex 109/1" were compared.

The spring oats under test were Resistance, Abundance and 4 selections from the cross Bountiful × Grey Winter.

The weather conditions in 1934 were most unfavourable for oats, and the results obtained from the first comparison of winter varieties above, although in general line with those of two previous years, did not furnish a corresponding range of differences in grain yield. The selections of the "ex 109/1" series grew more satisfactorily, but they also suffered from the drought, although less severely than any other oats in either quantitative or other tests.

Apart from quantitative tests, the oat cultivation included a long series of selections from the cross Resistance × Grey Winter, the "ex 109/1" series, and of Resistance itself, together with an F_3 generation of Avoine d'hiver × Argentine.

Peas.—The bulk of the work consisted of F_3 selections of the best Maple Dun types from several large crosses. The extraction of suitable Maple types from crosses between Unica and Glory and the best Maple strains has proved a failure owing to genetic linkages and complications in the inheritance of coat colour. The Dun crosses have proved quite successful and many good plant selections have been made with improved seed shape and colour, and of several days greater earliness in flowering.

Maple improvement is now being confined to crosses between a Tibetan Maple, which is early and has a short straw, and the best Maple strains available. This offers more promise than the Maple crosses referred to above. In addition, crosses have been made between all the best strains of Maples at present being grown with the sole idea of improving seed shape and colour.

Brassica.—Considerable time was given to producing callus buds on various species and hybrids, in the hope that tetraploid forms might be obtained, and the range of variation in the genus thereby extended. Success was eventually achieved on a considerable scale, but so far it cannot be stated definitely whether any of the shoots in question are tetraploids, since these will be difficult to recognise in the species, and in the hybrids they will be most easily picked out next season when seeds are set.

A further range of crosses was carried out by introducing the two Chinese species, *B. chinensis* and *B. pekinensis*, and Abyssinian mustard *B. carinata*. These were all crossed with swede or rape, turnip, and radish. The previous hybrids between turnip and radish were lost through cabbage root fly. The cross has been repeated, but it is difficult to obtain more than a very small number of seeds.

More seeds, presumably tetraploid, were obtained from the sterile radish × cabbage hybrids. These sterile hybrids are very vigorous and grew well in the drought. Some of the seeds set by them in the previous year proved to be tetraploids and gave some plants that set seed abundantly this year. It should be possible to examine the characteristics of this new form during the coming year.

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6. WELSH PLANT BREEDING STATION, ABERYSTWYTH

CEREALS.

Wheat.

There continues to be a steady demand for the pure line strains of "Hen Gymro". Owing to the severe incidence of smut in 1933, it has been necessary to isolate inflorescences by bagging in the manner used for self-pollination purposes, the heads so protected have been employed with a view to perpetuating the best lines in as smut-free a condition as possible.

Oats.

Oat breeding.—The oat breeding can now be considered in relation to the conditions for which the Station is catering.

(i) *Poor upland soils.*—Field trials with four of the advanced selections of the cross *A. brevis* × *A. strigosa* show that these selections give a grain of improved type and quality, while the yield of grain and straw has been at least equal to that of *A. strigosa*.

(ii) *Medium soils.*—Selections from crosses between Record and Radnorshire Sprig continue to give promising results—high yields of grain and straw being associated with good standing capacity.

(iii) *Good soils.*—Selections from a variety of crosses are giving excellent yields of grain of high quality and straw with remarkably good standing ability. Difficulty is still being experienced in combining these desirable characters with sufficiently early maturity.

Winter oats.—A large amount of material from crosses designed to give white-grained varieties with good standing ability and sustained winter hardiness are under test. A selection of more than usually high promise has been obtained from a cross between white-grained segregates derived from the cross Grey Winter × Kyko and Bountiful × Grey Winter.

Inter-species crosses.—The possibility of obtaining useful economic material for upland soils from the progeny of some of the inter-species crosses is being kept in view, but at the same time the genetical study of this material is being pursued as the main issue at the present time. The study of the inheritance of the character articulation, awn and pubescence of the grain is being continued in the different inter-species groups.

Synonyms.—The work of co-operation with the National Institute of Agricultural Botany in the identification of oat synonyms has been maintained and 16 varieties and synonyms were under observation during the year 1934.

HERBAGE PLANTS : BREEDING.

Grasses.

Cocksfoot.—A definite pasture type with broad leaves and high palatability, which starts growth early in the spring, has shown high promise in sward trials, and it has been decided to build up stocks of seed of this strain. Similar action is being taken with a definitely hay type—also early—but much more leafy than the ordinary Danish cocksfoot (15).

Other grasses.—With the number of species and the number of strains within the species in hand, it has become impossible to give equal attention to all sections. Main attention has therefore been concentrated upon those species which appear to be of the greatest importance, but other species have not been completely neglected.

Poa trivialis.—No special strain of this species has yet been established, and the species is left in comparative neglect although in fact it is very valuable under certain Welsh conditions. The reason for this comparative neglect is that seed available commercially has been found to give satisfactory results, and, although the species has been considerably explored, no plants, or collection of plants, of very special merit have yet been discovered.

Poa pratensis.—Two strains of this species are now well established and have been very favourably reported upon by those who have tested them in places as far apart as Sweden and Natal. This species does not appear to be of great importance in Wales, and it is doubtful if it has much application in England; for this reason extensive work upon it has not been undertaken. A third strain is, however, being built up. It may be noted that practically an unlimited number of strains of this species could easily be produced, and a large number of plants from various sources of origin have been studied with this in view. It was early noticed that isolation was not necessary, at least in the case of most plants, in order to produce a true breeding line. It has since been shown by Dr. Müntzing in Sweden that this is due to the fact that the seed is not produced by means of normal pollination and fertilisation.

Festuca ovina.—One strain of this species has been established for some considerable time. It is derived from seed originally collected on a ling heath in Pembrokeshire. Numerous collections of seed have since been made and tested, but none have shown any superiority over the old strain. Consequently, the work on this species consists mainly of the perpetuation of the strain and its further improvement by re-selection.

Festuca rubra.—Again, only one strain has been established, and this has given excellent results in sward trials. Several other types have from time to time been isolated and subjected to preliminary tests only to be discarded as being inferior for the purposes in view. The established strain is of composite origin and within the general type there is relatively wide variation. Greater uniformity to the best constituent type is, therefore, steadily sought for, and with this in view many selected plants and their progeny are continuously under study. New selections are made each season and new progeny families are similarly produced.

Phleum pratense.—Four strains have been established, and of these three are undoubtedly of very great value. The three strains in question have been very favourably reported upon both in this country and elsewhere, particularly in the U.S.A. and Canada, and requests for seed of these strains for experimental purposes are frequent. Each of the three is being improved by re-selection, and to some extent by the addition of suitable new material. As the species is an important one much time is devoted to it, both in the detailed study of selected potential parent plants and that of their progeny. Since the three strains are very different in type it is not sought at the moment to establish another and different strain, but it is desirable that further exploration for " indigenous " material should be undertaken in the near future, more particularly with a view to obtaining suitable material for inclusion in the old strains.

Italian rye-grass.—One strain has been established, and this, although not receiving the attention given to some other species, is also being improved by re-selection.

Lolium perenne.—At present there are two well-established strains; S.24 is of the " early hay " type and is intended directly to replace the ordinary commercial for short duration leys. It is both more vigorous and more leafy than the latter, while at the same time it is at least not less persistent. S.23, the other of these old strains, is a late flowering extreme pasture type suitable for the establishment of permanent pastures. The basis of this strain has now been broadened by merging with strain S.102. The two were not considered to be sufficiently distinctive to be kept apart. A third strain, S.101, is now being increased as rapidly as possible. This is derived exclusively from wild plants, but is intended partly to provide a heavy crop of good quality hay. It is late flowering and is still very leafy at the normal hay-harvest time, while it is expected to be far more persistent than the early flowering commercial type, particularly on fertile soil. In all these strains continuous re-selection is going on. The selected plants are themselves studied in tiller rows and their progeny as single plants.

Phalaris spp.—Very little work on *Ph. arundinacea* and *Ph. tuberosa* and their hybrid derivatives has been done in the present year, but a preliminary report upon plants raised from seed harvested from some of the hybrid derivatives sent to Australia shows that valuable material may be obtained from them particularly for irrigated areas.

Genetical work.—This work has been continued within the limits afforded by time and season. The main studies are concerned with the genetics of *Lolium perenne*, and the inter-relationships of certain genera and species, particularly the species of *Lolium* and *Festuca*. In the former section, a considerable amount of additional data has been collected. The study of intergeneric and interspecific relationships of necessity gives many negative results, but a paper published in December, 1933, shows that even in this field the results are by no means completely negative. Some new crosses which were made in 1933 gave germinable seed, and some new hybrid types came for study in 1934. The most interesting fact that emerged in this season is that when a perennial grass is intercrossed with an annual, the annual habit appears to be recessive inasmuch as plants which are strictly annual die completely after ripening seed, whereas the hybrids (which may flower but which may not produce seed) do not die back completely even at the approach of winter (8).

Legumes.

Clover breeding.—The breeding work with clovers has now reached the stage when field trials can be conducted, and as the result of such trials steps are now being taken to build up supplies of seed of the most promising strains. The following may be mentioned :—

> *White clover.*—A large-leaved strain of high productivity suitable for short-duration leys.
>
> *Red clover.*—A late-flowering strain possessing great winter-hardiness and persistency of the type of Montgomery and Cornish Marl.
>
> *Kidney vetch.*—In 1933 about 3,000 spaced plants, representing most of the races cultivated in Europe, were put out. During the past season about 250 of these plants were selected and selfed.

Genetical work.—Inheritance studies are confined to red and white clovers. The linkage relationships of various characters, e.g., sterility and certain flower colour factors, certain chlorophyll and leaf-marking factors, certain factors affecting plant size and leaf marking are also being investigated.

SEED PRODUCTION AND ISOLATION.

Forty-nine strains of grasses and clovers were multiplied for seed during 1934. This number includes initial multiplications as well as the further growing-on of stocks that have already been released. Ten strains of grasses were multiplied for seed on areas of one acre and over. The total area of grass seed harvested during the year was 33 acres. These stocks were grown on contract by eight farmers in the counties of Montgomery, Shropshire and Hereford, and do not include stocks grown on the Station's farm.

New contracts were made in the spring of 1934 with eight farmers to grow 11 grass strains involving a further 18 acres. The total acreage on contract in 1934 was thus 51 acres. Altogether during 1934, 17 farmers have grown pedigree grass and clover seed on contract for the Station. This total includes a number of growers in the immediate vicinity of the Station.

In the spring of 1934, 10 cwt. of extra-late flowering pedigree red clover was distributed for demonstration purposes throughout Wales.

1934 seed harvest.—The Station will have approximately 5 tons of pedigree seed from the 1934 harvest. Over 2 tons will be pasture rye-grass seed and there will be over 2 tons of cocksfoot seed.

All the seed crops were subjected to more intensive drought in 1934 than in 1933, and yet some exceedingly good yields were obtained, for example, the new pasture strain of cocksfoot gave 650 lb. of seed (firsts) per acre, and the pasture rye-grass gave 725 lb. of seed per acre on moisture-retaining soil in Hereford. 1934 suited such drought resisting plants as lucerne. An " island " of pedigree lucerne planted for seed on the Welsh border (Llanymynech) gave the very satisfactory yield of 540 lb. per acre.

PESTS.

Insect pests affecting grass and clover seeds were more numerous even than in 1933, and the high incidence on some of the crops emphasised the need for developing effective measures of control. The most serious damage was caused by *Apion* on white clover in Hereford and by gall midges on cocksfoot in Montgomery.

First harvest crops of cocksfoot were free from damage by midges, but severe injury was caused to fourth and fifth year crops.

Damage due to the timothy fly was definitely less in evidence during 1934 than in average years.

INVESTIGATIONS.

Work on the influence of nitrogen on seed production of creeping grasses has been extended, and there are indications that autumn applications of nitrogen may induce these grass types to yield heavier crops of seed. Investigations on a more extensive scale have been made into methods of growing leafy perennial rye-grass for seed and the manuring of this type of seed. The experiments already laid down for this purpose will be completed in 1935.

A further study has been made of the effect of differential management on seed production of late-flowering red clover. All the evidence suggests that on light soil and under low rainfall conditions it is best not to cut or graze such clover before putting up for seed, with the possible exception of grazing before the end of May.

Work has been continued on distance isolation of red clover and perennial rye-grass, and a paper on this subject is now in preparation.

Studies have been made on midge infestation of meadow foxtail at different elevations, and observations made on the distribution of midges on cocksfoot grown in various districts and under various conditions.

GENERAL GRASSLAND RESEARCHES.

Seeds mixtures: Competition and management.—A number of experiments have been put down to test the effect of various methods of after-treatment on the establishment of seeds mixtures. Data have been collected from innumerable seeds mixture trials in the counties and a report is in preparation.

Trials with sheep.—The extensive trial involving 48 pairs of tethered sheep to test by live weight increase the rival merits of a Station indigenous mixture compared with an ordinary "farmer's" mixture and to test indigenous cocksfoot against indigenous perennial rye-grass, and also the effect of including wild white clover in a mixture, has now run three years. During the year under notice (third harvest year) the "indigenous" mixture gave altogether better results than the "farmer's" mixture. The inclusion of wild white clover would appear definitely to add to the feeding value and to the drought resistance of the sward. The best results, as in previous years, were given by the plots consisting of indigenous perennial rye-grass and wild white clover.

The trials to ascertain the effect of different methods on old-established swards were continued and a preliminary report has been published on these results.

The buried and viable seeds of grassland.—These studies have been continued and much extended; and a paper on the subject has been published (13).

Palatability.—These studies have been continued (10, 11).

PLANT PHYSIOLOGY.

The investigation which has continued for some years into the reaction of grass seeds to germination in sugar solutions has been concluded. Although the number of strains examined is relatively small, it has become clear that although they are differentiated broadly by the foregoing reaction, the latter is also greatly influenced by the environment under which the seeds have developed. The value of the reaction as a diagnostic of genetical constitution is therefore destroyed; it is useful, however, as an index of seed-quality.

The relation between the mineral nutrition of grass seedlings and the amount of illumination they receive has been studied by the employment of different daily periods of light (as distinct from the earlier experiments in which intensity of lighting was varied). The minimum light requirement of seedlings (*Festuca pratensis*) is between 2 and 3 hours light per day. Seedlings receiving a marginal period of illumination survived for several weeks longer with low mineral nutrition than with high, but this observation requires the confirmation of further experiment.

The ability of seedlings which have been subject to very weak illumination for several months to recover and develop into seed-bearing plants has been demonstrated.

It has been found possible to desiccate grass seedlings of varied ages without destroying their vitality. Apparently the primordial tissue does not suffer desiccation because of the mechanical protection of the several sheathing structures. The property is not possessed equally by all species of grass.

The effect has been determined of reduced mineral nutrition and of recurrent drought on *Bromus hordaceus* (an annual grass). The points brought out were the flowering of all plants simultaneously with all treatments; the extreme diminution in size at maturity produced by mineral starvation and by drought. These results have some bearing on the systematic position of certain naturally occurring forms of this plant.

A comparison has been made between the temperature relations during germination of grass seeds grown in Britain and those obtained commercially, and also of samples of different ages. Significant differences have been shown but the data from this experiment have not yet been completely analysed.

A fairly complete record has been obtained of the reaction, during germination, to various environmental factors, of the seeds of those grass species used in agriculture.

Attempts have been made to induce delayed germination in seeds through the physical condition of the soil, but these have so far been unsuccessful.

Titles of papers issued during the year.

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2. ————: Note on a device for supporting seeds in contact with liquids. *Comptes rendus de l'Association Internationale d'Essais de Semences.* 1, 1-3, 1934. Copenhagen.
3. ————: The effect of soaking in water on the " seeds " of some *Gramineae*. *Ann. Appl. Biol.*, **21**, 2, 225-232, May, 1934.

4. Davies, W.: The management and manuring of pasture plants in relation to soil establishment and productivity. *Welsh J. Agric.*, **10**, 142-160, Jan., 1934.
5. ———: Grassland experiments in Mid-Wales: The Cilmery Park experiments. *Ann. Appl. Biol.*, **21**, 3, 379-397, Aug., 1934.
6. ———: Pasture legumes in relation to grassland improvement in Australia. *Empire J. Expt. Agric.*, **2**, No. 7, 228-238, July, 1934.
7. Evans, G.: Seed yields of pedigree and commercial grass strains. *Welsh J. Agric.*, 10, 131-142, Jan., 1934.
8. Jenkin, T. J.: Interspecific and intergeneric hybrids in herbage grasses. Initial crosses. *J. Genet.*, **28**, No. 2, 205-264, Dec., 1933.
9. Jones, Ll. I.: Pasture management and its effect on the sward. *Welsh J. Agric.*, **10.**, 267-278, Jan., 1934.
10. Milton, W. E. J.: The palatability of the self-establishing species contributing to different types of grassland. *Empire J. Expt. Agric.*, **1**, No. 4, 347-360, Dec., 1933.
11. ———: The relative palatability of seeds mixtures and a study of the influence of fertilisers on natural hill pastures. *Ibid.*, **2**, No. 5, 51-64, Jan., 1934.
12. ———: The effect of controlled grazing and manuring on natural hill pastures. *Welsh J. Agric.*, **10**, 196-211, Jan., 1934.
13. Milton, W. E. J., and Chippindale, H. G.: On the viable seeds present in the soil beneath pastures. *J. Ecol.*, **21**, 2, 508-531, Aug., 1934.
14. Silow, R. A.: A systematic disease of red clover caused by *Botrytis anthophylla* Bond. *Trans. Brit. Myc. Soc.*, **18**, Part 3, 239-248, Dec., 1933.
15. Stapledon, R. G.: Trials with strains of cocksfoot and observations on the policy of the Station in relation to their distribution and use. *Welsh J. Agric.*, **10**, 211-223, Jan., 1934.
16. ———: Palatability and management of the poorer Grass Lands. *J. Min. Agric.*, **41**, No. 4, 321-328, July, 1934.

7. SCOTTISH SOCIETY FOR RESEARCH IN PLANT BREEDING, EDINBURGH

CEREALS.

Oats.—Many unfixed oat hybrids were grown for comparison and selection and to provide genetical data. The search was continued for an improved high grain-yielding variety which does not readily lodge and possesses thin-husked grain. Several comparatively short-strawed plants which appeared to be breeding true, have been marked for more extended trials in 1935. These give promise of being highly productive and resistant to lodging, and they have a good quality of grain. In selecting hybrid types observations have also been made on the prevalence of " dry fleck " or " grey spot " as this malady has been prevalent in certain progenies of otherwise promising plants.

A new variety, specially suited for cultivation on some of the less fertile soils in various parts of Scotland, and earlier-ripening than the Potato oat, is being sought. Many early-ripening selections have been grown and compared, and some of the most promising of those that appear to be breeding true will be included in larger trials in 1935.

The Society's new variety, Elder, has been used as a parent for crossing with certain very early-ripening varieties, and some interesting material has been found in the progenies of these crosses. In view of encouraging reports from a number of growers of Elder oats, an elite stock of this variety is again being built up for distribution.

Further genetical data have been collected from a few crosses between black-grained and white-grained varieties and observations made regarding the occurrence of grey-grained types. The occurrence of black-grained and grey-grained plants in certain hybrid families has indicated that natural intercrossing may have been taking place and that aberrant types were the result. Data obtained from one F_3 family derived from protected F_2 plants however, seem to show that the aberrant forms are arising in some way other than by natural inter-crossing. About 500 F_2 plants derived from a protected F_1 plant of one of the white-grained × black-grained crosses, were protected individually from accidental cross-pollination to ensure that each plant was selfed, and the produce of these has been retained for study in 1935.

Several crosses were made a few years ago with a view to exploring the possibilities of developing an oat having grain which is specially suited for poultry feeding, and a group of hybrid progenies was grown for selection.

Thirty varieties, the majority of which were un-named ones raised at the Station, were grown in randomised plots and the yields of grain statistically analysed and compared. The prolonged drought in the early part of the growing season affected the yields, and these were below the average. This probably tended to obscure those varieties capable of giving the highest yield of grain, and many of them will be tried again in 1935.

The new oat (Potato × Record), referred to in the previous report as having been recommended for Registration, was named "Early Miller," and was duly registered by the Department of Agriculture for Scotland. The grain is of a type favoured by millers, and compares favourably in chemical composition with some of the standard varieties. There was a keen demand for the seed of which fifteen tons were available for distribution among members of the Society; encouraging reports have again been received.

Wheat.—The hybrid selections from a cross between a variety of *Triticum vulgare* and *T. spelta* were grown and further selections were made. A few lines which appeared to be breeding true were chosen for a preliminary mass-comparison. Selections were also made from several other hybrid strains for comparison with standard spring-sown varieties.

Barley.—The Field Trials Sub-Committee, Department of Agriculture for Scotland, recommended that, as there is a need for much purer stocks of "Common" barley than those generally available, it would be worth while selecting " pure " strains of this variety. The Sub-Committee agreed to provide a representative collection of samples of Common Barley from different crops grown in the North of Scotland and part of the collection was grown at the Plant Breeding Station for observation. A number of single-plant selections have been made for comparison in 1935.

POTATOES.

Further investigations were made on resistance to wart disease, and a paper dealing with the results of this work is being published. The effects of repeated self-fertilisation on several lines were further studied.

One of the Society's seedlings, reference number 135 (10), which has been included for four years in the registration trials carried out by the Department of Agriculture for Scotland, has been approved for registration by the Department. This new potato, now named " The Alness ", is an immune, early Second-Early variety, with white oval tubers of good cooking quality. About half an acre of this variety was grown in Aberdeenshire in 1934, and the crop grown there was found to attain the standard required for the award of a " Stock Seed " report by the Department.

Several of the Society's seedlings which have been included in the Department's registration trials, have been recommended for further trial in 1935. Certain of these which were also submitted to the National Institute of Agricultural Botany, for trial at Ormskirk, have been recommended for further trial there in 1935.

A few thousand new seedlings were raised at the Sub-Station at Ainville for comparison and selection, and for providing data to further the elucidation of the mode of inheritance of various characters. A proportion of these seedlings has been derived from crosses between a few wild tuber-bearing solanums and certain varieties of the cultivated potato, made with a view to introducing new characters from wild species, especially resistance to blight.

HERBAGE PLANTS.

The work on herbage plants has comprised the raising and comparison of strains of certain grasses and sea plantain, and the study of problems relating to the elaboration of methods for differentiating minor groups or strains of these plants.

One strain of cocksfoot and two more of diploid timothy were seeded. Part of a semi-natural upland pasture in East Lothian, the plants of which had been found to possess certain desirable characteristics, was fenced off in 1934 and the plants in the enclosed area satisfactorily seeded.

The rust disease of timothy rarely develops to any great extent at Edinburgh: accordingly the testing of new strains for rust-resistance is carried out by exchanging seed with Macdonald College, Quebec, Canada, where natural conditions are more suitable. One of the hexaploid strains of timothy sent out in 1931 has been found to be remarkably free from rust, as well as uniform in type and highly productive. Seed of this particular strain has been returned from Canada, and it will be further used for trials in Scotland.

It has been found that racial characteristics of herbage plants may be modified to such an extent by environmental conditions that, in the field, a strain composed of many different types assumes a false uniformity. The component types of a few races of certain herbage plants and of many ecological races of sea plantain were examined. In a number of populations of the latter species determinations of breadth and length of leaf, and of lengths of scape and spike were made on many individual plants and the figures obtained statistically analysed. Mean values for these measureable characters have been determined and various co-efficients and correlations are being worked out. An attempt is being made to find out if these mean values will provide a suitable basis for distinguishing strains the component plants of which represent a number of different genetic types and whether these values vary significantly when the plants are cultivated for a number of years.

On the basis of the data which have been accumulated an effort is being made to devise a practicable scheme for the testing and registration of different ecological strains or races of cross-pollinated plants such as those of many of the grasses of agricultural importance.

A few more trials of some of the Society's new strains of grasses have been arranged in collaboration with the three Agricultural Colleges in Scotland. Reports on the trials laid down in 1933 are, of course, not yet available.

SWEDES AND TURNIPS.

The examination of methods of breeding of root crops, and in particular the possibilities of producing true-breeding strains of swede by continued selection and by self-fertilisation under artificial isolation, was continued. Pedigree lines derived from commercial varieties were maintained. Some of those are now in their sixth generation of inbreeding and others are of more recent origin. New selections were made chiefly from the segregating generations of artificial inter-varietal crosses.

Further observations were made on the manner of inheritance of various characters such as colour of " flesh ", " skin ", and flower, type of foliage, shape and malformation of bulb, disposition to bolt, and resistance to disease. A plot larger than that previously used was available for testing strains for resistance to finger-and-toe disease, and a greater number of selections was made than in previous years.

The investigations concerning hereditary differences in composition as indicated by dry-matter percentage and bulb-weight were continued. Comparisons were made of a large number of F_3 generation strains mostly descended from one inter-varietal cross. These yield-trial plots were laid down to find out relative mean values, and subsequently a large trial of the same family was arranged for the autumn of 1935 to ascertain relative variability within the strains. Dry-matter tests and weights of individual bulbs were used as a basis for comparison in some other small yield-trials and also for the selection of types from segregating populations.

Pedigree lines were sown out in duplicate plots, with suitable controls, and observations made throughout the year. Trials were prepared for the purpose of determining yields at the end of the season. About 200 selected plants were self-fertilised under controlled conditions, and some artificial hybridisations were made. Sufficient quantities of seed for experiment were obtained from all the plants.

POTATOES—VIRUS DISEASE INVESTIGATIONS.

Plant Breeding Station, Corstorphine.—The elucidation of the question of transport of nitrogen fractions in healthy and crinkle-infected plants was attempted, and the whole of the results obtained were described in a paper read at the Conference of Virus Disease Workers held at East Craigs, Corstorphine, on 10th July, 1934. This investigation has now been concluded.

Considerable interference with the normal transport of nitrogen to the tubers seems to occur without visible necrosis of the conducting tissues. The main points of difference between healthy and crinkle-affected plants are :—

(i) synthesis of protein in diseased plants takes place at a later time in the growing season than in healthy ones;

(ii) there is a retardation of hydrolysis of protein in the crinkle-affected plants;

(iii) there is interference in such plants with the normal channel of transport of nitrogen fractions.

In the course of the breeding work attempts were made to ascertain whether any segregation was shown in the progeny of a " selfed " variety which is resistant to natural infection with virus diseases, and whether it were possible to synthesise an improved resistant form. The variety Shamrock appears to have a high degree of resistance to virus diseases, and it also possesses viable pollen. Seed from " selfs " of this variety was sown and over 300 seedlings were grown in an infectious environment. The seedlings could be classified into two groups : those apparently healthy, and those showing symptoms of infection with virus disease, but from the data obtained it was not possible to ascertain if segregation followed Mendelian lines.

Hybrid progenies from Epicure × Shamrock, and Epicure × Pepo were also grown in the infectious environment of Corstorphine for observation and comparison.

North of Scotland Sub-Station, Gibston, Huntly, Aberdeenshire.—Problems bearing upon the resistance of potato varieties to virus diseases have been further examined. Evidence has been obtained of the existence of two distinct types of resistance, viz. :—resistance to natural infection and resistance (tolerance) to the pathogen after infection. Although no completely resistant variety or seedling has yet been found, some are highly tolerant to individual viruses. Whenever possible tolerant varieties have been used as parents and the genetical aspects of these problems have been followed up by the raising of seedling progenies from highly susceptible plants crossed with very tolerant plants.

A comprehensive test of the method advocated by Appel for ascertaining the presence or absence of virus in potato tubers was made on 600 tubers from 53 varieties at frequent intervals over the period of winter storage, and it was found that the method was of doubtful value—a conclusion reached by other workers in this field.

The investigations into the metabolism of healthy and mosaic infected potatoes have been concluded. The early-ripening of diseased plants and the lower yields of tubers produced by these appear to be due to disturbances in metabolism which result in reduced " growth " activities.

Ainville Sub-Station.—It has been demonstrated that potato varieties fall into three classes of differing resistance to infection with the leaf-roll virus. An experiment has been made to determine whether this resistance is transmitted through the true seed. A number of " selfed " seedlings of Shamrock, a very resistant variety, and Pepo, which is susceptible, have been raised, and also a number of crosses between these two varieties and Epicure, Di Vernon, Catriona, British Queen, Dunbar Cavalier, and Abundance. A study of the extent of natural infection of these various seedlings will be made in 1935.

Diseased plants of the varieties President and Flourball were crossed reciprocally in continuation of the investigations on the transmission of " degeneracy " through true seed.

Titles of papers issued during the year.

1. Barton-Wright, E., and Alan McBain: Studies in the physiology of the virus diseases of the potato. II. A comparison of the carbohydrate metabolism of normal with that of crinkle potatoes; together with some observations on carbohydrate metabolism in a " carrier " variety. *Ann. Appl. Biol.*, **20**, No. 4, Nov., 1933.
2. ————: Studies in the physiology of the virus diseases of the potato. III. A comparison of the nitrogen metabolism of normal with that of leaf-roll potatoes. *Ibid.*, **20**, No. 4, Nov., 1933.
3. Robb, W.: Society's Annual Report for the year ended 31st March, 1934.
4. ————: Oat breeding in Scotland. *Empire J. Exp. Agric.*, **2**, No. 7, July, 1934.
5. ————: Experimental oat and potato breeding: Some recent developments. *Trans. Highl. and Agric. Soc. Scot.*, **46**, 126-145, 1934.

8. PLANT BREEDING DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

Oats.—The new variety, Stormont Kern, has now been included in the series of large scale trials of varieties for poorer cultural conditions for the past three years, and tentative conclusions may be drawn with regard to it. It seems unlikely that the variety will ever replace Tyrone Tawny or even Sandy for cultivation in really poor conditions. On the other hand there seems every probability that it will eventually replace Poland. It has done consistently well in districts in which Poland had hitherto given the best results. The variety is derived from the cross Potato × Sandy and is very much earlier ripening than Poland.

In good cultural conditions, especially in counties Down and Armagh, the use of Stormont Arrow is steadily increasing.

Flax.—A further season's test results effect no modification in the interpretation of the mass of data already accumulated. Larger seed supplies of Stormont Gossamer and Stormont Cirrus are now available but are still quite incommensurate with the demand. The acreage under flax is undergoing a very rapid increase from year to year which is certainly due to some extent to the extraordinarily impressive results obtained from the most recent introductions.

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9. NATIONAL INSTITUTE OF AGRICULTURAL BOTANY, CAMBRIDGE

Crop Improvement Branch.

Field trials and observation plots.—In field trials in 1933-34 there were fifteen varieties of winter wheat, five of winter oats, five of spring wheat, seven of spring barley, eight of spring oats, twelve of sugar beet, six of lucerne, eighteen of peas, and two of thousand headed kale. Of the winter wheats, three were tested under both normal and high farming conditions, three under high farming conditions, and nine under normal farming conditions. Thus the trials contained seventy-eight different stocks of which fourteen were new varieties.

The observation plots included, besides the crops mentioned above, winter barley, mangolds, swedes, marrow stemmed kales, rape kales, sainfoins, clovers and maize. Altogether over two hundred and fifty varieties of the principal farm crops were represented in this way. There were also small scale trials at Cambridge of eight varieties of autumn sown wheat, nine varieties of spring barley, and nine varieties of spring oats.

The majority of the trials and observation plots are repeated at all of the Institute's six centres, but where a variety is likely to have only a local interest or where conditions are unsuitable, it is omitted at some centres. Work confined to Cambridge consisted of trials of peas and thousand headed kale, the growing on of the living collection of cereals, the cereal synonym plots, and the multiplication of stocks of cereals and peas to provide uniform seed for future trials, and, in a few cases, for marketing.

As it had been impossible, owing to the abnormal season, to draw useful conclusions from the 1933 series of observation plots of mangolds and swedes, they were repeated in 1934 and it is hoped that they will provide material for field scale trials in 1935.

It was only in exceptional instances that the season provided a test of the standing capacity of any of the cereals.

The trials of winter wheats grown under conditions of intensive manuring were continued, as also were the observation plots of varieties of wheat sown at three different periods in the spring.

In the winter wheat trials one of the new varieties from the Cambridge University Plant Breeding Institute grown as 162/8/1E again gave outstandingly high yields under normal manuring, while another, W.70A, was highly productive when grown on the silt at Kirton. Both of these wheats have stiffer straw than probably any established variety.

In the winter oat trials, Resistance, grown under the number 136/17, again demonstrated its high yielding capacity.

The spring wheat variety, W.81, has now been included in trials for three years and in 1934, as in 1932, it heavily outyielded its control, April Bearded. Over the whole period it has outyielded its control in five out of eight completed trials. A report on the variety will appear in the Institute's Journal.

In the spring oat trials, Eagle maintained its reputation for high yields, outyielding its control at every sub-station.

A new series of spring barley trials was commenced in 1934. The varieties included were Dr. Beaven's Plumage-Archer 1935, grown under the number 35/7, Webb's New Cross, and Kenia, the last being grown as a possible variety for late sowing.

The series of lucerne trials commenced in 1930 at Bridgham and Good Easter were continued. At Bridgham, Hungarian and Grimm again gave heavier cuts than Provence, but in this, the fourth, year of the trial the English strain was heavily outyielded by Provence. The Marlborough and Medanose strains again made a very poor showing. At Good Easter the Hungarian and Marlborough strains improved considerably on their showing in 1933 and gave yields of produce not significantly different from those of Provence. Both Grimm and English strains were again very inferior to Provence.

Quality.—The Institute has had the good fortune to have the best technical advice from other bodies in determining quality this year as in the past.

An essential part of this work is the determination of the moisture content of the produce of all trials; comparison of the gross yields of two varieties of any crop may be quite unfair if the produce varies greatly in dry matter content; consequently the results of all trials are expressed as yields of dry matter.

Moisture determinations and analyses of sugar beet and other root crops continue to be carried out on the Institute's behalf by the Cambridge School of Agriculture.

Samples of wheat were sent to the Home Grown Wheat Committee of the National Association of British and Irish Millers, and of the barleys to the Institute of Brewing. The work undertaken includes not merely the valuation of the grain, but also a series of detailed analyses, together with actual milling and baking tests of the wheats and malting of the barleys. Samples are sent, both from all field trials and from observation plots, so that it will be realised that the number is large; no charge however is made for testing them, and in effect these bodies make annually large donations to the Institute. Several commercial experts also kindly valued the cereals.

Co-operation with other bodies.—The close relations between the Institute and the Plant Breeding Stations at Cambridge and Aberystwyth have been maintained during the year, as may be evidenced by the inclusion in trials of a large number of varieties of wheat, oats and peas originated by them.

The Institute is also testing varieties of oats produced by the Scottish Society for Research in Plant Breeding and by the Plant Breeding Division of the Department of Agriculture for Northern Ireland; a variety of wheat received from the Albert Agricultural College, Glasnevin, Dublin; and a number of varieties of cereals and peas produced by private and commercial breeders. As regards new varieties of sugar beet, it is testing ten strains of Kleinwanzleben and eighteen other strains.

Trials of different kinds have been carried out on behalf of the Institute by Armstrong College, Newcastle-upon-Tyne, at Cockle Park; by the Agricultural Institute at Kirton; by the Hertfordshire Institute of Agriculture; and at Selby. In addition, farmers in different parts of the country have submitted a number of varieties to field tests.

Such assistance is of great value in increasing the range of conditions under which varieties can be tested. Results obtained at the five sub-stations of the Institute are applicable to a great part of the country, and will be still more generally applicable with the establishment in 1935 of the sub-station at Askham Bryan in Yorkshire, but there must remain a number of soils and districts where special trials are advisable in order to establish the suitability of certain varieties to local conditions.

In co-operation with Directors of Research Institutes and Agricultural Colleges and with County Agricultural Organisers, the county spring oat trials were continued for the fourth year. It was felt that sufficient information had been obtained as to the qualities of Victory and Marvellous and these varieties were replaced in 1934 by Eagle and Progress.

The same varieties, Star, Golden Rain II, Eagle and Progress will be tested in 1935, and with the conclusion of next year's trials it is hoped that sufficient data will have been compiled as to their characteristics. It is proposed to commence a series of county winter oat trials in the season 1935-36, and to include in them the varieties Resistance, Grey Winter, and two new varieties raised by the Welsh Plant Breeding Station. It is hoped that the simplicity of the trials required and the undoubted value of the information obtained may lead to a considerable increase in the number of bodies taking part in both the 1935 spring oat trials and in the 1935-36 winter oat trials.

It has been suggested that county trials of wheat varieties should be commenced in the near future; it is felt however that the institution of such trials might profitably be delayed until more information is available as to the qualities of new varieties which are, or soon may be, available.

The value of co-ordinated variety trials is great; apart from the educational value of the trials in the districts in which they are grown, they provide the only means of discovering the comparative merits of a variety when grown under widely varying conditions.

Seed growing.—During 1934 the produce of 152 acres of Resistance oats was harvested for seed. This was the second occasion on which the Institute had arranged for the marketing of a new cereal variety, the previous introduction being that of Yeoman II wheat in 1924. In that year unusually inclement weather greatly increased the difficulties of harvesting a good crop, and in 1934 the continuance of the drought seriously reduced the yield of Resistance oats suitable for seed.

Altogether about 1,100 quarters of grain were harvested, but after dressing only 660 quarters were available for distribution to the seed trade. This considerable reduction was due in part to the high standard of the samples required by the Institute, but it also serves to emphasise the expense involved in the introduction of a new variety.

Nineteen acres of a stock of Spratt-Archer barley, supplied by the Cambridge Plant Breeding Institute, were grown on contract in 1934, and it is proposed to offer the produce for sale in the spring of 1935.

Twenty-six acres of a selected stock of Yeoman II wheat and twenty-five acres of Wilhelmina are in process of multiplication to provide about 100 quarters of each for sale in the autumn of 1935.

Smaller areas of a pure stock of Little Joss, of the new wheat W.70A raised by the Cambridge University Plant Breeding Institute, and of a new white winter oat, S.82, produced by the Welsh Plant Breeding Station, are being grown on contract as first stages in multiplication for possible future marketing, the latter being dependent on the results of trials now in progress.

It had been hoped to commence the bulk multiplication of the wheat, 162/8/1E, produced by the Cambridge Plant Breeding Institute. This variety has consistently given outstandingly high yields in the Institute's trials under conditions of both normal and intensive manuring, and has exceedingly stiff, short straw. During 1934 however, a number of red chaffed plants made their appearance, and it was clear that some outcrossing had taken place. It was therefore decided that a small quantity of typical white chaffed ears should be selected from the crop, and that the grain from these should be grown in isolation. The delay involved in the multiplication of this wheat is most unfortunate, but it would clearly be undesirable to multiply the 1934 bulk stock.

It will, therefore, be several years before the variety is available for distribution.

Seed for the county spring oat trials was supplied at cost price to those participating and will be supplied in 1935, and in 1934-35 four acres each of Resistance, Grey Winter, and of two varieties of winter oats raised by the Welsh Plant Breeding Station will be grown to supply seed on the same terms for the proposed county winter oat trials commencing in 1935-36.

Cereal synonyms (2 (*c*), 5).—Stocks of suspected synonyms were again grown at Cambridge and also by Mr. T. E. Miln, the Welsh Plant Breeding Station and the Seed Testing and Plant Registration Station for Scotland. The Committee had in addition the co-operation of the North of Scotland College of Agriculture and the Institut für Landwirtschaftliche Botanik, Germany, in testing some of the suspected oat synonyms for frost resistance. Some idea of the progress made can be obtained from the following figures. In 1928, ten of the leading seed firms listed a total of 132 names of wheat, barley and oats of which 35 (26 per cent.) were synonyms. In 1934 the same ten firms listed only 99 names of which 17 were synonyms, and of these 17, 15 were offered by two firms only. A further promising feature is that although two or three firms continue to list a number of old synonyms, only about three new synonyms have been put on the market during the last few seasons.

Sugar beet.—During August, 1934, with the approval of the Informal Committee of the Ministry of Agriculture on Sugar Beet Research and Education, the Director made an extensive tour of sugar beet research institutes and commercial seed firms in the chief continental sugar producing countries. Valuable insight was gained into the methods employed in the production of improved strains of sugar beet seed and into the general state of the beet sugar industry.

The series of yield trials for testing sugar beet strains commenced in 1933 was continued in 1934, the only change being the addition of Johnson's Perfection to the strains in the early lifting trials.

Although the summer of 1934 was dry, good crops of sugar beet were obtained at all centres. The "plant" was excellent everywhere except at Sprowston, where some loss resulted from wireworm. There have been no serious outbreaks of pests or diseases. In addition to the trials thirteen strains were grown in observation plots at five stations from seed as supplied by factories to growers in 1934. This is being done at the request of the Factories' Committee to check the identity and quality of the commercial stocks supplied. At the same five stations twenty other strains were grown in observation plots from seed obtained direct from breeders, four strains being included for the first time. In addition, twenty-four plots were grown at Cambridge only to provide comparisons between the stocks grown in the trials and the factory stocks.

OFFICIAL SEED TESTING STATION.

The Station tested 29,487 samples in the twelve months ended 31st July, 1934, the number of samples received from outside sources being 27,077. These figures are rather lower than those of the previous year, which were swollen by the increased interest in wheat in the early days of the quota. The large number (2,410) of investigational samples bears witness to the research activities of the Station.

At a Conference of Malting Barley Growers and Maltsters, held at Rothamsted in October, 1934, the point was made that maltsters would not accept the Official Seed Testing Station barley germination figures as proof of suitability for malting, as these did not indicate the germinative capacity within the first three or four days. In the usual way this is so, but whenever asked to do so, the Station is prepared to supply information as to the germination taking place within any stated number of days.

The Station has again co-operated with the New Zealand Seed Testing Station, Palmerston North, with respect to the deterioration of parcels of Chewings Fescue shipped to this country. The results obtained have been published in an article by Mr. N. R. Foy of the New Zealand Station in the July number of the New Zealand Journal of Agriculture.

A very large amount of investigational work has been carried out both in the greenhouse and in the open as to the effect of dressing peas with mercurial dusts. This work is now being extended to a field scale. In conjunction with the Agricultural Seed Trade Association, field trials were also carried out in 1934 in the hope of throwing further light on the condition known as "Marsh Spot" in peas.

The Wild White Clover Growing-On Committee met on the 31st July and examined the plots sown in 1933 together with those held over from the previous year for re-examination. The number of plots passed up to 31st July was 616 and the number sown 872.

No seed testing course was held in 1934, nor was there a seed analysts' conference, but the usual reference samples of different types of seed were prepared by the Station and were distributed by the Ministry of Agriculture to the licensed stations.

POTATO TESTING STATION.

Yield and maturity trials.—Although dry weather persisted throughout the greater part of the growing period, the season was marked by the delayed maturity of all but the early varieties, due to the complete absence of blight and to the rainfall of August and September.

The only yield trials at Ormskirk were those of varieties entered for the Lord Derby Gold Medal trials. Of these varieties Dobbie's Asset and Seedling 149/11 sent by Mr. D. MacKelvie of Lamlash had been included in the 1933 trials which were ruined by the July storm in that year. Two other varieties were included in 1934. As a result of the trials the Committee decided to award a Gold Medal to Seedling 180/14, and a report on this variety, which has been named Arran Signet, will be published in due course in the Institute's Journal, together with the results of the other trials.

The study of " potato sickness " of land has been continued. In collaboration with Manchester University, investigations were made of means by which eelworm might be eradicated. A field which had for some time been infested with eelworm was divided into three parts, one of which was dressed with calcium cyanamide; another was sown down with a grass mixture for short periods; while the remainder was treated as a control.

It has been established that the practice of boxing seed tubers leads to an increase in crop, but there is no information as to the effect of boxing for different lengths of time. This is a point of practical importance and also one which should be investigated from the point of view of yield trial technique, since where seed is received from a number of different sources it is not always possible to arrange for the same period of " chitting ". A trial was therefore arranged of Kerr's Pink grown from seed boxed immediately after lifting and on two subsequent dates.

By courtesy of the Director the variety Arran Pilot was again included in a trial at the Agricultural Institute, Kirton. In 1933 it gave a yield not significantly greater than Duke of York, but this year it significantly outyielded both Duke of York and Dunbar Yeoman as a first early.

During recent years the development of the potato crisp trade has reached considerable proportions, but the value of this development to the British farmer has been reduced by the fact that it has not been thought possible to supply the whole of the factories' requirements from home grown potatoes. A continental variety which appeared to be unknown in this country, was said to be specially suitable for the trade, and has been imported for some years. A supply of seed of this variety has been obtained by the Institute, and it has been included in a trial with King Edward and Majestic at Cambridge. It was also grown in observation plots at Ormskirk and included in trials at Kirton.

Official immunity trials at Ormskirk.—Owing to the late appearance of wart in 1933, it had been impossible in that year to adjudicate as to the immunity of some of the varieties submitted for trial, and they were accordingly included for a second time in 1934. Wart infection of all susceptible varieties was good in 1934, and no doubts could be entertained as to the reliability of the results. There were 43 entries for the first year trial, and 26 for the second, while 18 came from the official stations of Northern Ireland and Scotland under the scheme of inter-departmental checking. Three of the latter were duplicates of others sent for test, but of the 84 remaining new varieties, all but three were free from wart in the field. 124 entries were received for the seedling trials and were tested in the field. 977 tubers were tested in the laboratory, of which only 1·1 per cent. rotted. These tubers represented 81 varieties sent for the immunity trials, 113 varieties sent for the susceptibility trials and 9 established immunes. Specimens from the contact tests were sent to Miss Glynne at Rothamsted Experimental Station for examination.

The problems raised by the lack of correlation between the results of field and laboratory methods have continued to receive attention. All those seedlings which showed winter sporangia in the indoor test at Ormskirk were given a duplicate test in the field. This consists of planting five tubers in the most highly wart infected piece of land on the farm. The land which is used for this purpose is really a wart compost and all field susceptible varieties planted in 1934 showed 100 per cent. severe infection. Yet none of the varieties which bore casual winter sporangia indoors showed any sign of infection in the field.

Potato synonyms.—Not a single synonym was to be seen among the entries for the immunity trials. The reduction in the number of synonymous varieties has gone on steadily since the Committee was appointed fifteen years ago, and it now remains to reduce the small number of synonyms which are regularly offered by seed potato vendors. Plots of twenty-three of these were grown in 1934 at Ormskirk, and it is felt that they will continue to be offered until the public refuse to buy them.

Other activities.—Investigations were continued into the method of laboratory determination of the health of seed tubers by the insertion of strips of copper. It was decided that the method of test was of little value.

Titles of papers issued during the year.

1. Fourteenth Annual Report.
2. *J. N.I.A.B.*, **3**, 3, 1933.
    - (*a*) Parker, W. H.: The methods employed in variety trials by the National Institute of Agricultural Botany.
    - (*b*) Hawkes, F. C.: Cereal crops in Essex, 1927-1929.
    - (*c*) Cereal Synonyms.
    - (*d*) Humphries, Sir A., Humphries, S., and Read, L. H.: The quality for breadmaking purposes of wheats harvested in 1932.
    - (*e*) Armstrong, S. F.: Trials of sugar beet strains, 1930-1932.
    - (*f*) Parker, W. H.: Potato variety trials, 1931-1932.
    - (*g*) Parker, W. H., and Bryan, H.: Lord Derby Gold Medal potato trials, 1932.
    - (*h*) Eastham, A.: Fourteenth annual report of the O.S.T.S. for England and Wales (1930-31).
    - (*i*) Twelfth Annual General Meeting of the Fellows of the Institute.

FARMERS' LEAFLETS.

3. No. 4. Lucerne. (Revised edition March, 1934.)
4. Potato Synonyms.
5. Cereal Synonyms.

10. PLANT REGISTRATION STATION, DEPARTMENT OF AGRICULTURE FOR SCOTLAND

POTATOES.

Laboratory tests for immunity from wart disease.—The number of varieties subjected to test in 1934 was 898 of which number 219 proved susceptible to wart disease. Of varieties to the number of 53 in their second year of field test, one only exhibited that degree of susceptibility in which the parasite completes its life history. Of 55 varieties submitted for registration for the first time nine proved to be susceptible under laboratory test and under field test.

The application of the intensive test under routine conditions to accredited immune varieties in series of 50 tubers each has shown that under these conditions a variety of slight susceptibility may exhibit a range of reactions, varying in degree, to intensive infection.

Field tests will in future be dispensed with, their place being taken by pot tests.

Virus diseases scheme.—This scheme was operated under a special sanction valid until the end of 1934, when the active participation of the station in the selection, multiplication and maintenance of healthy stocks of potato varieties ceased. Henceforward the work will be regarded as a function of the advisory services operated by the three Scottish agricultural colleges.

Between the inception of the scheme and 1934, 112 stocks of 26 varieties have been approved for distribution as virus-free stocks while 10 additional stocks are still in the initial stages of propagation.

The abnormal incidence of leaf roll in 1933 and 1934 has had an adverse influence on the accumulation of virus-free stocks, the disease appearing in many of the stocks which had been built up from virus-free selections.

Skin spot investigation.—This investigation was developed in a series of field experiments at various centres throughout Scotland.

11. CROP (AND ANIMAL HUSBANDRY) DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

Grassland.—The experiment commenced in 1929 to investigate some of the problems concerned in the management of grassland has been continued. In 1931 plots 1, 4 and 5 received a complete dressing of Nitrogen, Phosphates and Potash; plot 2 Phosphates and Potash only, and plot 3 Phosphates only. No further application of Phosphates and Potash has since been applied, but plots 1, 4 and 5 have received annually 1 cwt. per acre Sulphate of Ammonia in spring. Plots 1, 2 and 3 have now been grazed four years, while plots 4 and 5, which were ploughed up and sown down to seeds at the commencement of the experiment, were cut for hay the first year and have now been grazed three years.

In the fourth year the general appearance of plots 1, 2 and 3 was much inferior to that of plots 4 and 5, but despite this there was again no significant difference between the five plots as reflected by the method employed to show their stock carrying capacity. It was again noticeable, however, that the stock showed a marked preference for plots 4 and 5.

Unfortunately the water supply for the field was again inadequate during the prolonged dry weather of the fourth grazing season and the stock had to be removed from all plots. This factor seriously interfered with the grazing and the figures so far obtained do not, therefore, indicate the maximum stock carrying capacity of the plots.

Barley.—With the large increase in the pig population in Northern Ireland an endeavour is being made to encourage the home production of barley and the feeding of barley meal to pigs. An experiment was carried out to test the suitability of varieties, under average soil conditions, for the production of barley for feeding purposes. The varieties tested were Spratt Archer, Golden Archer, and Old Common. Satisfactory yields were obtained from all three varieties and the experiment will be repeated with the addition of the new Scandinavian variety " Abed Kenia ".

Cost accounts.—The keeping of cost accounts has been continued on the farm of the Agricultural Research Institute, the sixth consecutive year being completed on 31st March, 1934. Abstracts from the accounts have been used in articles published on the production of young beef and on the piggeries erected at the Institute, and the accounts have also proved of value in providing figures for management, teaching and advisory work.

12. SEED TESTING (AND PLANT DISEASE) DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

SEEDS.

Ultra-violet light tests.—In connection with the use of this test for distinguishing species and strains of *Lolium* (referred to in the last report), certain definite conclusions have been reached and work is being discontinued. The test is now in routine use in seed testing stations in many countries for determining the proportion of true perennial ryegrass present in samples described as " Italian ryegrass," and distinguishing certain strains of perennial ryegrass.

Utilizing this method some hundreds of British samples described as Italian ryegrass have been examined for the presence of perennial ryegrass. The results are somewhat disturbing since they show quite clearly that most lots of British so-called Italian ryegrass contain material proportions of perennial ryegrass. This would seem to indicate that the sale of mixed ryegrasses as " Italian ryegrass " is a not uncommon practice. The proportion of awnless seeds is in practice a rough guide to proportion of perennial ryegrass present, and where this figure is higher than about 15 to 20 per cent. it is almost certain that a material proportion of perennial ryegrass is present. Ordinary purity report figures do not give the amounts of perennial ryegrass present in samples of Italian ryegrass, a fact which should be carefully borne in mind by those laying down grass seed mixtures, particularly where the ratio of perennial to Italian ryegrass is an important consideration.

Indigenous strains of grasses.

(i) *Strains already purchasable.*—Repeat sowings of the trials laid down in 1932 in collaboration with the County Instructors in Agriculture, in which half-acre plots sown with standard mixtures containing indigenous and commercial grasses respectively, were compared, proved impracticable in 1933, but in 1934 a further series on similar lines was laid down. The 1932 mixtures were modified in the 1934 plots in accordance with results obtained in 1932 and 1933. In view of the necessity for hay in the first year and of the relatively slow establishment of indigenous perennial, the sowing was increased from 15 to 20 lb. per acre and 6 pounds per acre of commercial Irish Italian ryegrass was introduced, bringing the total sowing per acre up to 40 pounds as against the light seeding of 30 pounds used in 1932. It is hoped that this mixture will help to suppress weeds better than the original mixture as well as improving the first-year hay, without militating against the establishment of the indigenous strains.

The results so far recorded for the 1932 sowings are rather variable and it is thought that in a large measure this may be due to variation in grazing practice between centre and centre.

It is clear that different species respond very differently to grazing at given times and seasons, and it seems very probable that strains such as those of the ryegrasses exhibiting markedly different peak seasons, will vary in response after the same manner. In general, the indigenous plots are definitely improved as compared with their 1933 condition and on the average are now showing to distinct advantage over the commercial plots, except at centres where two hay crops were taken. The general appearance of the plots to date suggests that indigenous ryegrass, at least, is desirable for grazing purposes in Northern Ireland, but that it cannot be subjected to the somewhat cavalier husbandry which is fashionable. The "cheapened" indigenous mixture trials have not been repeated.

(ii) *New strains.*—The small-scale plots of various perennial ryegrass strains, laid down at the Agricultural Research Farm, Hillsborough, came into their first harvest year in 1934. Half of each plot was mown with a motor lawn-mower at intervals during the 1934 growing season. The produce of the sub-plots was weighed in the green state and a representative sample of each was dried at 100° C. and the dry matter estimated. The remaining half plots were harvested for hay and seed about the end of July. The results to date show wide differences between the strains under test, but final conclusions cannot be drawn until the plots have been under trial for a further period.

Industrial seed production.—The Aberystwyth élite strain of perennial ryegrass sown in 1933 for seed production at the North-West School Farm, Strabane, showed promise of a first-class crop so far as it was growing on clean land, during the early summer of 1934. In the few weeks immediately prior to harvest, weather conditions were disastrous and so much seed was lost through "lodging" that data of seed weights produced proved valueless. In spite of the weather, however, a bulk of seed showing a germination of over 90 per cent. was saved. This trial was not repeated in 1934, but it is hoped to repeat it in 1935.

Meantime, the County experiments referred to in an earlier paragraph, sown in 1934, include a number of trials in good seed-saving districts where seed-producing mixtures have been sown (perennial ryegrass 36 lb. per acre, no Italian, no Alsike clover), for the purpose of ascertaining the productivity of the same Welsh strain under our conditions. These will come to harvest in 1935 and will be pastured thereafter in accordance with the usual practice.

Value of damaged seedlings.—The trials carried out in collaboration with the Dublin Seed Testing Station, referred to in the previous issue, have been reported to the International Seed Testing Association and the report has been published (1).

Seeds mixture for littoral aerodrome.—The plots laid down in collaboration with the Belfast Harbour Commissioners on reclaimed land in Belfast Lough, have shown that if sown within about two years of dredging, none of the ordinary grasses or clovers used in common agricultural practice succeeded well. Among them, perennial ryegrass made the best attempt and produced a result which might be regarded as fair where it had been supported by manuring at the time of sowing (complete artificials). The next best, although definitely poorer were fiorin and *Poa trivialis.* Neither of these, however, made any serious success in the absence of manure. Much the best result was obtained, manured and unmanured, from sea-washed red fescue, the seed of which, however, is very scarce and expensive. The area is being naturally colonized strongly by *Poa maritima* and the collection and redistribution of this seems to offer a possible method of clothing such land in the early stages of reclamation.

Determination of variety by suction-force tests.—The experiments previously referred to have been carried a little further and some improvement has been made in the technique of the test. A large number of materials have been tried in an attempt to reduce the difficulties arising through mould development. Up to date the most encouraging results have been obtained by dispersions of saponin. Preliminary trials with this suggest that it may prove a useful material in combining the required osmotic properties with disinfectant properties. A preliminary report on this work has been published (2).

Weeds.—A preliminary part of the collaborative system of experiments upon the eradication of rushes, referred to in the last issue, has been laid down at the Agricultural Institute, Hillsborough. An extensive series of overlapping mowing trials designed to show the effect of varying numbers of cuttings per annum, when these cuttings are begun early in the year and when they are begun late, is in operation and promises to give interesting results by the spring of 1935. It is hoped to proceed with other cultural, manurial and poisoning operations during the coming season.

Titles of papers issued during the year.

1. **Lafferty, H. A., Mercer, S. P., and Linehan, P.A.: On the evaluation** of broken seedlings which produce adventitious roots during a germination test. *Comp. rend. de L'Assoc. Internat. d'Essais de Semences.* **6**, 2, 1934.
2. **Kirkwood, F. R., and Mercer, S. P.: Note on the technique of the** Buchinger method of determining " suction force ". *Ibid.*, **6**, 2, 1934.

HORTICULTURE AND GLASSHOUSE CROPS

13. LONG ASHTON FRUIT RESEARCH STATION, UNIVERSITY OF BRISTOL

FRUIT CULTURE.

I.—PLANT NUTRITION (1).

(a) *Rootstock problems.*

Field trials.—Records were continued on the trial plots of apple trees on Long Ashton selected layered stocks and on graded seedling stocks at Long Ashton and various local centres. Several of the layered stocks may be classed as vigorous but have brought trees into bearing rather earlier than some other vigorous stocks. Several stocks are proving comparative failures at most of the trial centres.

Additional trial plots of standard trees have been planted at Kington, Worcestershire, and Wellington, Hereford.

One set of standard trees and two of bushes are being raised in the nursery to complete the present series of trials of layered stocks.

On the trial plot of apples on the Malling rootstocks detailed field records are now only taken for the variety Worcester Pearmain. The variety Lane's Prince Albert is being used for chemical investigations relating to rootstock effect.

The first heavy crop of plums was obtained on the plum rootstock plot and detailed cropping records were obtained. There appeared a large percentage recovery from silver leaf on this plot during 1934.

Laboratory work.—The investigation relating to the effects of rootstocks on the mineral constituents of the shoots and fruits of two varieties of apples was completed.

The main results were as follows :—

(i) Rootstocks produced significant effects on both pomological and chemical characters.

(ii) Correlations were established between certain chemical constitutents, and between some chemical and pomological features.

(iii) The dwarfing effect of Malling No. IX rootstock could not be explained chemically.

(iv) Rootstocks Malling II and V had many characters of low potassium plants even under conditions of favourable supply of the element.

(v) Rootstocks promoting great vigour showed agreement in respect of one character only, a high $\frac{K}{N}$ ratio in the shoots.

(vi) Although rootstocks produced significant differences as regards certain chemical constituents, many of the outstanding rootstock effects could not be chemically explained.

The effect of several apple rootstocks, Malling Nos. II, V, VII, IX and B, on the cycles of nitrogenous, carbohydrate and mineral constituents in the terminal shoots of the variety Lane's Prince Albert is being examined.

(b) *Stock and scion relationships.*

The effect of intermediate stem pieces.—In this experiment the effects of stem pieces of the Malling rootstocks Nos. II, IX and XIII are being determined, using the varieties Worcester Pearmain and Bramley's Seedling as bush and standard trees respectively, worked on the above rootstocks. Effects due to rootstocks and stem pieces are apparent in the trees.

The effect of rootstocks in increasing the vigour of a scion variety.—Apple trees consisting of Malling No. IX rootstock as scion variety worked on the rootstocks Malling Nos. II, IX and XIII and on miscellaneous seedlings have been grown through the nursery stage and their growth histories recorded. The data are now in course of analysis.

The influence of the scion variety on root morphology.—Further records obtained on bench grafted apple trees show that scion varieties affect considerably the morphology of the roots of seedling varieties on which they are worked, thus confirming previous observations.

The use of bench grafting in the production of standard trees.—Batches of trees raised by this method are being planted out for trial under grass orchard conditions. The nursery performance of the trees has been excellent.

(c) *Manurial experiments.*

Pot experiments.—The programme of pot work has been extended, two new experiments being added.

(i) Apple trees, variety Cox's Orange Pippin, in soil from an apple manurial plot at Long Ashton. The object is to compare similar manurial treatments under field and pot conditions. In the field potash deficiency is marked and this has also appeared in the pot cultures.

(ii) Apple trees, variety Bramley's Seedling, in sand to study the effect of a high phosphorus diet. The trees have grown well during the first season.

The older experiments were all continued. Efforts to stimulate trees under the deficiency treatments (omit N, P, K, Ca and Mg), have so far only succeeded with the " omit *K* " cultures.

In cultures receiving high potassium diets, chlorosis due to iron deficiency developed, which was easily remedied by applications of iron citrate. The results suggest a relationship between potassium and iron.

Field experiments.—(i) *At Long Ashton.*—No new plots were commenced and records were continued on the established plots.

The plants in the raspberry experiment laid down in the previous year are well established in spite of two successive drought summers. The material has been thoroughly rogued. The effects of the manurial treatments are not very striking only two *K* deficient plots showing obvious effects.

The strawberry plots suffered severely from attacks of tarsonemid mite, and the attack will seriously vitiate the present planting.

On the apple deficiency plots, potassium deficiency continues to be the one outstanding feature. On the poorest *K* starved plots, the trees are showing considerable die-back. Gooseberries interplanted also show *K* deficiency symptoms very markedly.

In the black currant deficiency experiment, potassium deficiency is also the most marked feature; the best plots are those receiving the complete fertiliser and dung.

(ii) *At other centres.*—Potassium deficiency is the outstanding feature on all crops on the plots at Cannington Farm Institute. Black currants also show effects from lack of nitrogen.

The apple trees at this centre are just entering the bearing stage.

The experiment in Herefordshire where Cox's Orange Pippin is being grown with adequate potash manuring on an area where apples have hitherto always failed continues to show excellent results.

At the Sussex centre where magnesium and potassic fertilisers have been applied to apple trees affected with a blotching of the foliage, the blotching symptoms again failed to appear but marked potassium deficiency occurred, especially on the variety Superb, on the plots originally untreated with potassic manures.

(d) *Soil moisture experiments.*

The high and low moisture Bramley's Seedling trees were grown in the greenhouse and outside as in the previous season and in each series half of the trees were given double the normal nitrogen dressing and the other half four times the normal amount.

In spite of the increased dressings all trees appeared to be low in nitrogen, especially in the high moisture series grown outside. Attempts to spray the trees to check certain pests and diseases caused serious damage to trees in the dry series, particularly those in the greenhouse.

Good crops of fruit were borne by both sets of high moisture trees but the final crop in the greenhouse was seriously depleted by Codlin Moth, which fact greatly reduced the number of fruits available for storage tests. The harvested fruits are being tested under both ordinary and cold store conditions.

Observations on physiological troubles to fruits occurring on the trees—cork and water core—and in store—bitter pit—again support the view that high temperatures are the primary causes of these troubles.

(e) *Leaf scorch of fruit trees.*

The apple trees, Cox's Orange Pippin on rootstocks Malling Nos. I, II, V, and XIII, growing in sand, were fed with a complete nutrient solution of high potassium content to overcome the serious effects of *K* deficiency. The trees responded well on all stocks, but particularly on No. II. The treatment induced iron deficiency which was especially marked on No. I. After a further season's treatment with the complete nutrient solution the trees will be subjected to potassium deficiency again.

(f) *Lime-induced chlorosis.*

Experiments on the treatment of lime-induced chlorosis of apple, pear and plum trees by the dry salt injection method of Bennett have shown that the method is of commercial value, being especially useful where grass culture cannot be practised.

(g) *Cover crops.*

Comparisons are being made on apple trees between the three systems, grass + nitrate, grass + nitrate + mulch, and clean cultivation without nitrate. The trees under the grass systems continue to show improvement but are still less vigorous than those under clean cultivation.

The seasonal cycles of soluble nitrogen constituents and of various carbohydrate substances in the terminal shoots of the variety Newton Wonder growing on the plots have been followed and the results published (2, 3).

The higher vigour on the arable plots is reflected in the shoots by higher soluble nitrogen, higher sugars and lower carbohydrate/nitrogen ratios. The different systems do not alter the forms of the cycles.

(h) *Tree shaping and pruning.*

The apple trees used in this experiment were shaped according to plan by the spring of 1934 and bore their first heavy crop in that season : interesting data on the suitability of the various forms for carrying heavy crops were obtained. In particular the strength of the Modified Leader trees was demonstrated.

(i) *Bark ringing.*

Owing to the abnormal droughts of 1933 and 1934, it has been possible to determine the effects of such drastic conditions on trees (apples, pears, and plums) ringed by various procedures. Observations have shown that trees ringed with a complete ring and the ring left uncovered suffered severely, whereas when half rings were used or whole rings covered immediately with waterproof tape the trees have not been harmed.

(j) *Biennial bearing of apples.*

The blossom and fruit thinning experiments on the variety Early Victoria have been continued (4). The results reported to date show that blossom thinning has resulted in more regular blossoming but the effect of this treatment on biennial bearing has not been determined so far since a biennial tendency in blossoming on unthinned trees has not yet been accompanied by biennial cropping.

(k) *Seasonal cycles of nitrogenous and carbohydrate materials in apple trees.*

The object of this work is to determine how the seasonal cycles are influenced by various factors which affect vegetative growth and fruitfulness. So far cultural systems (2, 3) and rootstocks have been considered. (See Sections I (*a*) and (*g*).)

(l) *Storage qualities of fruits*—(see Section IX).

II.—SURVEYS OF FRUIT SOILS.

Mapping has been commenced in the cider fruit area around Martock, Somerset, but work was greatly hampered by the drought conditions which prevailed throughout the season of 1934.

The soils of the Research Station farm are being mapped on a scale of 25 inches to 1 mile.

III.—INVESTIGATIONS ON SOFT FRUITS.

(a) *Strawberries.*

Cultural Problems.—Work has been continued along the lines described in the previous report.

Clonal selections have been made and propagated. In " strain " trials of Royal Sovereign and Oberschlesien large differences have been found between different strains. Some of these differences seem to be related to freedom or otherwise from recognised pathological conditions.

In variety trials Pilnitz, Western Queen and Gaddesden have been added. The vigorous variety " Evesham Unknown " has been received at Long Ashton under at least five different names. None of the new varieties possess the merits of Royal Sovereign.

The pollination experiments with Royal Sovereign, Oberschlesien and Tardive de Leopold, have been extended to field plots and to small greenhouse trials. The Oberschlesien variety sets perfect trusses when planted alongside Royal Sovereign in the field.

(b) *Raspberries.*

Variety nomenclature and classification.—An identification key for varieties, with notes on varietal characters, has been prepared (5).

Cultural problems.—The rogueing of stocks of various varieties in preparation for further field work has been continued.

(c) *Black Currants.*

Pruning experiments.—Experiments comparing the effects of hard and light pruning on the varieties Boskoop, Baldwin, Seabrook and Edina have shown that the former method hastens ripening of the berries by several days.

(d) *Red Currants.*

Variety and pruning trials.—Trials of several new varieties are in progress, combined with tests of pruning methods. In particular, the effects of leaving a considerable proportion of new wood are being compared with the orthodox system of hard pruning, involving the removal of much of the new growths. So far the light pruning methods have compared favourably as regards crop with the hard pruning system.

(e) *Gooseberries.*

Variety nomenclature and classification.—The work has been continued.

Variety trial.—This will be concluded shortly.

Summer pruning.—The experiments have been carried out mainly to determine how far summer pruning can overcome the difficulty of " breaking " shoots with varieties such as Leveller. The removal of unwanted shoots and the shortening of others just prior to " green " picking time has enabled satisfactory bushes to be grown and also has facilitated picking.

IV.—Fruit Breeding.

Observations and selections of seedlings were continued on apples, pears, plums, black currants, raspberries and strawberries.

Among apples, several families, including the crosses Worcester × Beauty of Bath, Worcester × Rival, Worcester × Charles Ross and Worcester × Mackintosh Red, cropped for the first time.

One pear of promise was selected for further trial. No new selections of plums or black currants were made but several raspberries were marked for further trial.

The blackberry Ashton Cross cropped more heavily than Himalaya Berry, but rather less than Black Diamond, with which variety it was compared for the first time. The flavour appeared superior to the latter.

Under the seedling distribution scheme, black currants, the blackberry Ashton Cross and the pear Bristol Cross were distributed.

Wisley Variety Trial Scheme.

Apples.—The oldest varieties in the trials, Laxton's Superb and Herring Pippin—6 years planted—are both growing vigorously on the rootstocks Malling Nos. I, II, XII. Both cropped in 1934, the fruits of Herring Pippin being too large and soft for commercial purposes. St. Cecilia has proved very sensitive to sulphur damage. The variety Monarch, which is stated to be very resistant to canker, has become badly affected where exposed to a serious source of infection.

Black currants.—The variety Raven has proved a vigorous grower and a medium cropper, the quality of the fruit being excellent, but it does not appear superior to standard sorts like Boskoop, Seabrook or Baldwin. Wellington XXX is growing well but crop records are not yet available.

V. Pests and Diseases and their Control.

(a) *Reversion disease and big bud of black currants.*

The plots on which the relationships and spread of these two diseases are being studied continue to show that the spread of " reversion " cannot be related to known sources of infection.

(b) *Control of capsid bug on black currants by tar oil-petroleum winter washes.*

The control of this pest on black currants by the above washes has been reported as unsatisfactory in the Bristol Province for the past three seasons.

Experiments were carried out in 1934 to determine the cause of these failures. The results confirmed previous experience that good control can be obtained by using the Long Ashton mixed wash, consisting of high boiling tar and petroleum oils in equal proportions. Spindle oil also proved a satisfactory substitute for " half-white " petroleum oil. Poor results can only be attributed to inefficient spraying technique.

(c) *Raspberry moth or " red grub " (Incurvaria rubiella).*

Previous observations have indicated that it might be possible to control the larvae at the time of emergence from their winter quarters about the period of bud break. Preliminary experiments showed that good control could be obtained by watering the shoots at that time with tar oil emulsion, but this caused damage to the plants. For three seasons prior to 1934, the larval migration extended over a three week period but, in 1934, when emergence was late, the majority of the larvae entered the buds within a few days. This uncertainty of time will make timing of washes at this period difficult.

Preliminary spraying trials at the migration period, using oil-bound lead arsenate and oil-bound ground derris root have been carried out but the results are inconclusive.

(d) *Apple sawfly* (*Hoplocampa testudinea*) (6, 7, 8).

As a result of previous experiments, a highly satisfactory technique has been evolved for controlling this pest at hatching time and in the larval stage by means of mixed washes in which nicotine and lead arsenate are used as the toxic principles against sawfly.

The method was applied on a large scale in 1934. Infestations were much lower than in 1933, but oviposition was abnormally late, and hatching extended to the point when the calyx cups were closing after petal fall. The abnormal conditions rendered the choice of spraying dates extremely difficult but in spite of this good results were obtained, although inferior to those of 1933.

(e) *Apple blossom weevil* (*Anthonomus pomorum*).

Observations on the weevils have shown that they are attracted to the trees principally at the early " green bud " stage, reaching the buds either by walking along the shoots or more rarely by flying to the trusses.

Derris dusts were not very successful as repellents, heavy applications being required which were readily removed by wind and rain. Barium silicofluoride was better than derris but caused leaf and bud injuries.

(f) *Woolly aphis* (*Eriosoma lanigera*).

In nursery experiments attention was paid to the cleansing of the trees when lifted prior to removing to permanent plantation or orchard positions. The complete immersion of the trees for about 5 minutes in a 10 per cent. tar oil emulsion provided a satisfactory control and did not injure the trees. For treating growing trees in the nursery during summer, the most satisfactory methods were brush applications of refined kerosene—for small scale work—and application of nicotine washes containing high percentages of wetters.

For established trees, tar oil washes do not provide adequate control and the most satisfactory method consists in the application of a nicotine wash as described above. High spraying pressures are essential.

(g) *Plum sawfly* (*Hoplocampa flava*).

This pest is serious on the varieties Victoria and Czar.

Methods of control similar in principle to those evolved for apply sawfly were tested, an attempt also being made to control red spider simultaneously.

Single and double washings were applied after petal fall—single two weeks after, and double one week and 17 days after. The washes used were as follows:

Single spraying: lead arsenate and oil emulsion; lead arsenate and derris; lead arsenate and lime sulphur. Double spraying: nicotine and lead arsenate followed by oil emulsion and derris; nicotine and lead arsenate followed by oil emulsion and lead arsenate.

None of the washes gave a commercial control of sawfly, probably due to the exceptionally late emergence of the adults, but excellent control of red spider was obtained. Cover washes as a means of killing wandering larvae appeared of little value.

(h) *Red spiders on fruit trees.*

Observations have been made on the hatching of red spider eggs and on the behaviour of the pests. Laboratory trials were made on the action of lime sulphur, derris, rotenone, pyrethrum and oil emulsion as contact acaricides and ovicides. All the preparations killed the active mites on contact but (with the exception of petroleum oil emulsions) were unable to kill moulting mites or summer eggs.

(i) *Strawberry pests.*

Tarsonemid mite. Of the experimental treatments of runners detailed in the previous report, lime sulphur and oil dipping treatments proved entirely ineffective against mite and pyrethrum dipping only produced slight control. Hot water treated plants suffered a serious check to growth but the method provided complete control of the mite.

(j) *Die-back in plums* (*Bacterial stem canker*).

The trials previously reported were continued and further batches of Burbank's Giant Prune and Victoria on Myrobolan B, Kentish Bush and Egg Plum stocks were planted out at the Fladbury centre. No cases of Die-back have occurred in the trials.

(k) *Die-back in apples.*

A number of cases in Worcestershire have been kept under observation and the associated fungi have been isolated and tested for pathogenicity. No highly parasitic fungus has been isolated, and the feebly parasitic *Valsa ambiens* previously encountered has been found to be widespread.

(l) *Apple canker.*

The control of canker in young trees is being attempted by spraying treatment. Batches of Worcester and Cox's Orange Pippin have been treated as follows : in the nursery by Bordeaux, Bordeaux + white oil, and Bordeaux + a proprietary wetter ; after planting out one batch has been further sprayed with Bordeaux + cotton seed oil.

(m) *Apple and pear scab.*

The present phase of the investigations on these diseases concerns the use of mixed washes with insecticidal and fungicidal properties for the control of Scab (7, 8).

A summary of recent investigations on Apple Scab has been prepared (9). The account refers to scab infections of the shoot, spread of infection in spring, times for spraying, spray damage and choice of fungicide, and gives a spray programme for several English varieties.

(n) *Strawberry diseases.*

Root rots.—A survey of root rots occurring in the Bristol Province has been made. Fungi identical with those isolated by Berkeley at East Malling were obtained. Only a small number of the fungi, such as *Cylindrocarpon radicicola* appeared to be actively parasitic.

Virus disease.—A pathological form, which appears identical with the American " crinkle " has been observed to be prevalent in the West Midland strawberry areas (9).

(o) *Blackberry stem rust* (*Kuehneola albida*).

Spraying trials with Bordeaux mixture and copper lime dusts were carried out at Long Ashton. The results will be judged in 1935.

(p) *Fruit spots and fruit rots.*

Several fungi causing prevalent fruit rots have been inoculated on to healthy and injured (by burning) twigs of apple trees. Few of the fungi can cause lesions on healthy twigs but many, such as *Alternaria tenuis* and *Botrytis cinerea*, can persist and multiply on dead twigs. The latter thus form an important source of fruit infection.

(q) *Virus diseases of tree fruits and small fruits.*

The possibility of the occurrence of virus diseases in tree fruits is being explored. Plum Pox and other suggestive conditions are under observation.

Seedlings of raspberries, black currants, red currants and strawberries are being raised under insect-free conditions for work on virus diseases.

In strawberries special attention is being given to " crinkle " (10).

VI. SPRAY MATERIALS AND CONTROL METHODS.

(a) *Oils combined with protective sprays.*

Lime sulphur combined with a white oil (emulsified with sulphite lye) was applied at the green flower stage to a wide range of apple varieties for the simultaneous control of capsid and red spider eggs and scab. At the same period a Bordeaux-oil-nicotine-arsenate spray was applied on cider varieties at Long Ashton. The absence of scab frustrated an estimate of the fungicidal efficiency of these washes but in no case did serious spray or insect damage result.

As a post-blossom application, a lime sulphur-oil-nicotine mixture was applied on Worcesters at Long Ashton and gave an adequate control of sawfly. On a plot of seventeen apple varieties a lime sulphur-oil-lead arsenate post-blossom wash was applied without spray damage.

On black currants, a field trial of the oil-lime sulphur wash was made after bud burst for the control of capsid eggs and big bud. A satisfactory control of capsid was obtained but control of big bud cannot be ascertained until a later date.

(b) *Spreader trials.*

In the laboratory, progress was made in establishing a technique for the comparative examination of substances used as spreading agents.

In the field, Bordeaux mixture in combination with various spreaders was used in trials against potato "blight" (*Phytophthora infestans*). A range of spreading agents in conjunction with nicotine plus lime sulphur was tested in an apple sawfly trial in the Bristol Province. In other tests, the addition of wetters to mixtures of lime sulphur-oil or lime sulphur-arsenate, caused no increase of spray damage.

(c) *Ferrous sulphate mixtures.*

At Long Ashton, and in commercial plantations, the addition of ferrous sulphate to lime sulphur-arsenate-nicotine mixtures was shown to cause no reduction in the standard of apple sawfly control. Mixtures including lime sulphur, oil, arsenate and ferrous sulphate caused no spray damage in post-blossom trials on the principal commercial apple varieties at Long Ashton and elsewhere in the Bristol Province.

(d) *The ovicidal action of petroleum oils.*

The commonly accepted explanation that the toxic action of petroleum and high boiling neutral tar oils on capsid eggs is due to the interference of the respiration of the developing ovum is without adequate proof. As a preliminary to an investigation of the subject, problems relating to the insertion of capsid eggs in bark and the fate of oils applied to bark are under examination.

(e) *Derris extracts and rotenone as substitutes for nicotine.*

The substitution of such products for nicotine would have obvious advantages. In chemical studies attempts have been made to standardise derris extracts by chemical and biological tests.

In field tests rotenone was compared with nicotine against apple capsid and apple sawfly. It appeared as effective as nicotine as a contact wash against capsid and as an ovicide in the case of sawfly, though the latter point requires confirmation.

(f) *Technique for laboratory trials of toxicity.*

Experiments are in progress to determine a range of test insects suitable for various laboratory scale tests, and a suitable technique for handling insect material in laboratory trials.

(g) *Copper fungicides.*

The mechanism of the action of copper in fungicides is under investigation with a view to determining a basis for standardising copper sprays. A number of copper sprays—cupric and cuprous derivatives—have been compared with Bordeaux mixture on potatoes. Both fungicidal and chemical aspects were considered.

(h) *Fungicidal action of sulphur.*

Results now available suggest that the constituent or constituents of the living cell responsible for the reduction of sulphur to hydrogen sulphide are normally present in traces only and do not accumulate owing to their rapid oxidation. They appear to be complex substances containing the cysteine or a related sulphhydryl radicle, their formation being due to the action of an enzyme destroyed by temperatures over 60° C. Continuous formation occurs in leaf tissues of certain plants until that temperature is exceeded.

The investigations of the nature and degree of sulphur sensitivity of individual varieties of fruits were continued, but owing to the exceptional hot and dry summer the available material was unsatisfactory for the requirements of work of this character and the results were too irregular to be of service in testing the provisional conclusions drawn from the previous year's work on this subject.

(i) *Spray Damage.*

Investigations of the causes of russetting of Cox's Orange Pippin following the application of soap-nicotine washes are in progress.

(j) *Spraying technique.*

Further experiments were carried out concerning the use of a mobile spraying unit for plantation and grass orchard work. Special attention was given to nozzle discharge rates, the use of various pressures and comparisons with systems involving the use of movable pipes.

An automatic pressure regulator valve for use on spraying machines has been developed.

FRUIT PRESERVATION AND PRODUCTS.

VII. Cider.

(a) *Variety trials* (12).—Competitions for cider varieties of apples were again held. There were 84 entries. The juices were characterised by their high specific gravities. Samples were also tested from the Burghill Cider Trial Orchard and two samples of new varieties, Bulmer's Norman and Michelin.

(b) *Detection and estimation of metallic elements in cider.*

(i) *Lead.*—A colorimetric sulphide method has been found satisfactory for lead contents of 5-20 p.p.m.

(ii) *Copper.*—A final procedure has not been adopted. The normal copper content of cider is 1-2 p.p.m. The filtration of solutions through a Swedish No. 1 F. ashless filter paper results in loss of copper by absorption.

(iii) *Tin.*—This has been successfully estimated by the use of Buchanan & Schryver's reagent (dinitrodiphenylamine sulphoxide), but the element does not appear in ciders in appreciable amounts.

(c) *Centrifuging of ciders.*—The experiments previously outlined have been almost completed (14). The main effect of the centrifuge in retarding fermentation appears to be due to the removal of nitrogen from the liquid. Large numbers of yeast cells are also removed but sufficient remain to promote active fermentation given a suitable medium.

(d) *The role of pectin in cider-making processes.*

(i) *Decomposition of pectin during fermentation.*—Using the calcium pectate method of estimation, pectin has been shown to be present in ciders in only negligible amounts after fermentation has proceeded to the point when a fall of 20 points in gravity has occurred. At this stage definite alcohol precipitates of "pectin" could be obtained. Alcohol precipitate figures were generally 50 per cent. higher than those obtained by the calcium pectate method.

(ii) *Changes in pectin content during maceration.*—The process of macerating the juices of culinary varieties with bitter sweet pomace showed that this resulted in a decreased tannin content. Since the quality of the juices was improved the effect of the process on pectin content was examined.

It was shown that the maceration process resulted in increased pectin contents, a maximum content of approximately 0·30 per cent. occurring in three days followed by a fall to 0·27 per cent. The addition of pomace to pure water resulted in similar changes.

Juices and water extracts fermented after the maceration treatment contained only traces of pectin and the improved flavour of the treated cider could not be attributed to increased content of pectin.

(iii) *Sweetening dry ciders with pomace extract.*—The sweetening effects of pectin preparations when added to dry cider have been investigated. Pectin preparations were prepared by extracting dried pomace with cold and hot water respectively and subsequently evaporating both solutions in vacuo until a concentration of 3·0 per cent. pectin was obtained : a proprietary syrup containing 3·0 per cent. crude pectin was also used. These were added to samples of dry cider and as a control treatment a similar sample was treated with a sugar solution of the same sugar content as the pectin solutions. After filtering and standing for 3 months no difference in sweetness or flavour was observed in the various ciders and pectin was only present as a trace in each liquid; a deposit occurred in each of the pectin treated samples.

(e) *Enzymes in cider-making processes.*—Experiments were carried out on the effect of removing pectin from ciders prior to bottling with a view to preventing deposits. Four enzymes and five widely differing ciders were used; some of the ciders were Seitz-filtered, while others were filtered through a clarifying pad. All the Seiz-filtered products remained free from deposit but the others all formed deposits which possibly varied in character. Enzymes appeared to effect important clarification changes only in the case of high acid ciders.

(f) *Dilution of cider.*—The effects of diluting cider with water and sugar syrup are under investigation. Pleasant products have been obtained.

(g) *Maceration treatment.*—Details of technique in macerating the juice of culinary varieties with bittersweet pomace have been examined. The good effects of maceration treatment, previously reported (15), have been confirmed.

(h) *Suitability of woods for cider storage.*—Various types of wood are under trial.

VIII. FRUIT PRODUCTS.

(a) *Juices.*—The processes of heating and of limited fermentation as means of obtaining optimum yield and clarity of juice have been compared. The latter appears superior but takes longer.

(b) *Syrups.*—The addition of 100-200 c.c. of concentrated citric acid solution per gallon has been found to improve the quality of most fruit syrups.

(c) *Squashes.*—A new series of products has been prepared in which fruit tissues are present in the syrup. To ensure attractive products it is necessary to obtain definite textures of the tissues and to adjust the colours by means of suitable colouring materials.

(d) *Wines.*—Fermentation of juices in wine making is aided by prolonging the initial fermentation period prior to expressing the juice.

The use of various sugars for fermenting is being explored, e.g. Brewers Invert, Sucrose and Liquid Glucose.

Various types of yeasts are under test, including some Long Ashton sorts and Champagne and Reisling types.

Experiments on the maturing of wines indicate that products may be improved by such treatments as adding shavings and aerating at intervals.

(e) *Distillates.*—The characters of the various fractions which may be distilled from fruit wines have been examined. The first 10 per cent. of the distillate is usually of a pungent aldehydic character. Liqueurs have been prepared from the various fractions and these differ markedly in quality.

(f) *Use of pulped fruits for wines.*—The removal of sulphur dioxide from fruit pulps by various methods has been attempted. An SO_2 content of 800 p.p.m. was reduced to 156 p.p.m. by hydrogen peroxide and to 97 p.p.m. by gentle heating.

(g) *Costing of syruping and wine-making processes.*—The cost of the raw fruit is a comparatively small percentage of the total cost of the products. Syrups and wines appear capable of yielding reasonable profits.

(h) *Fruit bottling.*—It appears possible to decrease the period of sterilisation usually recommended in domestic fruit bottling substantially by using hot bottles and covering the fruit with boiling liquid. By this method the period has been reduced from 1½ hours to 30, 20 and 15 minutes in certain cases. No cases of poor keeping have resulted so far from the use of the new technique.

(i) *Fruit canning.*—The possibility of exhausting the air from cans between filling up with syrup and spinning on the lids in home canning is being tested on gooseberries, raspberries, black currants and plums.

(j) *Jam making.*—Problems of crystallisation are being investigated from the viewpoints of the use of different sugars and of varying the boiling period.

The use of pectin in jam making is being examined, especially in relation to keeping quality, firmness of set and sugar content (16).

IX. STORAGE EXPERIMENTS.

Storage Qualities of Fruits.

As the weather conditions during 1933 were abnormally hot and dry, special attention was given to two points which it was thought would be of particular interest in these circumstances, viz., breakdown in Worcester Pearmain and the incidence of cork, bitter pit and related troubles.

Samples of Worcester Pearmain were obtained from various districts from plots where manurial and other treatments showed much diversity. As was surmised, the high temperature conditions which had prevailed resulted in very high quality fruits susceptible to Low Temperature Breakdown, the latter being of relatively rare occurrence in this variety in seasons of normal sunshine. Samples are to be taken from the same centres for two or three seasons to verify further this apparent relationship between high temperature and breakdown in the variety.

During 1934, arrangements were made through the Ministry of Agriculture with the County Councils of the Isle of Ely and Norfolk and the Wisbech Fruit Growers' Association, to carry out an extensive investigation of the occurrence and control of bitter pit in the Wisbech fruit area and centres were selected for preliminary work. The first point to be examined is the incidence of bitter pit in Bramley's Seedling in selected orchards, and its relation to meteorological factors. The work will be carried out in close co-operation with the Horticultural Officers of the Norfolk County Council and Isle of Ely Authority. Samples have been taken for tests from the 1934 crop from six orchards.

Observations on cork and water core showed that these were prevalent during the season which accords with the view that high temperature is a major causal factor.

Interesting data were obtained with Worcesters from the manurial plots at East Malling. Very clear effects on breakdown and rots in cold store due to both rootstocks and manurial treatments were established. On the manurial side nitrogen or potash used alone increased rots and breakdown; used together the effects of these were much greater than when used singly. Rootstock No. V., which gave poor quality fruits was outstanding for low percentage rots and breakdown whilst Nos. IV and VII, which yielded high quality fruits showed high percentages.

For the continuance of work on manurial effects, manurial experiments have been established at East Malling, Long Ashton, Chelmsford, Goostrey (Cheshire) and Cannington (Somerset).

The centre at Chelmsford is of special importance in view of the fact that the variety used is Cox's Orange Pippin growing on two rootstocks, Malling Nos. II and IX. The data should thus be of great value in elucidating storage problems of this variety for East Anglian conditions.

1933 was the final season for tests of fruits from manurial plots at Hutton, Lancashire. The results of the tests from this Station have been entirely consistent since 1927 and have shown clearly the effect of potassium deficiency in rendering fruits liable to damage by low storage temperatures.

Chemical Investigations.

In the chemical investigations work has been continued on the effects of the various orchard factors examined on the contents of the major constituents of the fruits. A point of importance in the 1933 data was the abnormally high values obtained for dry matter, acidity and sugars in all samples, this being a result of the special character of the summer—abnormally hot and dry.

X. WILLOW CULTURE AND THE UTILISATION OF WILLOWS.

(a) *Variety trials.*—The vigour of new varieties raised from seed has been greater, under drought conditions, than those of older varieties raised from cuttings.

(b) *Pests and diseases* (17, 18).—Evidence has been obtained that a " canker " of young bat willow trees results primarily from frost injuries on pruning wounds.

(c) *The culture of salix alba, var. caerulea* (*cricket bat willow*) (19).—Experiments on the raising of sets were continued. Rooted sets were found superior to unrooted sets in withstanding drought conditions.

Hybrids from controlled crosses of *Salix caerulea* and *Salix alba* are being raised.

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14. EAST MALLING RESEARCH STATION

POMOLOGY.

IN RELATION TO TREE FRUITS.

(a) *Rootstock investigations.*

Apples.—The past year has seen heavy crops of apples on the main rootstock experiments on Lane's Prince Albert and Bramley's Seedling, which have now completed their fifteenth season.

It has been found that Lane's Prince Albert trees on the most vigorous rootstocks continue to give an increasing crop each year: trees on stocks of intermediate vigour, however, now show a slight falling-off in crop.

Bramley's Seedling has shown a marked biennial tendency during the last four seasons and this year all trees had their maximum crop so far—the larger trees on Nos. II, XVI and XII bearing between nine and ten bushels per tree. It may be noted moreover that the earlier cropping trees on such stocks as Nos. VII and IV show as yet no signs of deterioration; those on No. IV actually averaged 10 bushels per tree—their heaviest crop to date.

The crop of Cox's Orange Pippin on all rootstocks (now in their thirteenth season) continues to increase. The trees on the intermediate stocks are still well ahead of those on the most vigorous (such as No. XVI).

The Worcester Pearmain stock trial showed signs this season of having suffered from overcrowding by the adjacent Bramley's Seedling and all these trees showed a slight falling-off in crop.

It has been necessary to thin some of the mixed plots of Bramley's Seedling and Worcester Pearmain. One of these was dealt with by removing the Bramley's and replacing them by Worcester Pearmain from another source, together with a few Cox's Orange Pippin for pollination. The effect of transplantation on trees of this age will be studied.

Analysis of rootstock influence, including the reciprocal effect of scion on root.—The series of Lane's Prince Albert trees, "stem worked" and "root worked" on vegetatively raised rootstocks and upon seedling roots have now been three seasons *in situ*, having been planted as two-year-olds in January, 1932. Up to the present the relative vigour and amount of fruit bud formation of trees on Nos. IX, II and XII repeat the performance of the earlier series of stem worked trees and there is no evidence to show that the elimination of the stem piece has altered this in any way. The trees on seedling rootstocks are on the average somewhat less vigorous than those on No. XII, but at present they are not more variable in size. In fruit bud formation they appear more variable than on No. XII, which has uniformly produced very few fruit buds. While on the average the trees on seedlings have had rather more blossom than those on No. XII, in no case do they equal the performance of trees on Nos. II and IX in this respect.

Counts of fruit set confirm these results.

Comparison of the microscopic structure of the roots and rootstocks of Worcester Pearmain and Lane's Prince Albert worked on Nos. II, IX and X with each other and with unworked rootstocks has revealed differences here as well as in the gross structure. In furtherance of this investigation, the structure of a complete range of unworked rootstocks is to be studied, as well as the comparative effects of various scions. For this last work, Bramley's Seedling, Lane's Prince Albert and Grenadier have been worked on each of rootstocks Nos. II, IX and XII.

A complex trial of Cox and Worcester single cordons on rootstocks Nos. I, II, IV, VII, IX and XII will be planted this winter. The treatments include two distances of planting, viz. (*a*) 1 foot 9 inches, (*b*) 3 feet 6 inches apart in the rows, and two methods of pruning, viz., (*a*) summer, (*b*) winter + summer pruning. The trial is planned so that two manurial or other remedial measures can be superimposed later as occasion arises.

Pears.—In the autumn, the results of 20 years' investigations upon rootstocks for pears were reviewed (15). The methods of classifying, identifying and standardizing (by vegetative propagation) quince and free pear stocks were summarized; and the phenomenon of incompatibility of certain Quince and Pear stocks in the nursery were recalled.

A comparison was made of the vigour and cropping of 10 year old trees of Dr. Jules Guyot on five selected " free " pear stocks. Similar characteristics of three varieties on quince and seedling pear stocks were compared and the growth characters peculiar to trees on pear and quince described. Individual trees on seedling stocks were shown to have cropped quickly and it was suggested that desirable " free " stocks might be selected and standardised.

The vigour and cropping of seven varieties—from 10 to 14 years old—on various quince stocks were detailed. The general utility of Quinces A and B were compared; it was shown that after nine years nearly all trees on Quince C fell behind in vigour, owing to the superior cropping on that stock; but Quince D was shown to be a most undesirable variety.

The phenomenon of scion rooting, especially of trees on quince, was described and shown to be of common occurrence. The detrimental effect on cropping was illustrated.

Plums.—Records of size and cropping of a considerable range of varieties on clonal rootstocks are being continued; and it is hoped to present a report in the near future.

Comparisons of ungrafted plum trees on their own roots with those on different rootstocks are now yielding interesting information. Some varieties on their own roots are found to be as vigorous as trees on Myrobolan, while others approximate more nearly to trees on the more dwarfing Common Mussel rootstock.

Similarly with cropping, while practically all varieties on their own roots have cropped at least as well as trees on Mussel, in several cases, notably Victoria, Pershore Egg and Warwickshire Drooper, the yield has been considerably higher; and this is not entirely due to superior vigour.

Peaches.—The trained trees of Hale's Early planted against a board fence set a moderate crop which was successfully harvested.

The clonal races of common peach raised by layering will be included in nursery trials as opportunity offers.

Cherries.—The available number of acid cherry stocks is increasing and it is hoped will be large enough at the end of 1935 for a trial of sweet cherry scions on Mazzard and acid cherry stocks.

Propagation.—Further nursery trials of new rootstocks of apple, pear, plum and cherry will be planted, as these stocks become available, to test compatibility with commercial scion varieties and to obtain preliminary records of stock effect as shown in new wood growth and fruit-bud formation. The nursery testing of new apple rootstocks, immune to Woolly Aphis, has been continued in collaboration with the Plant Breeding and Entomology sections.

Signs of incompatibility are apparent amongst very few of the seedling *Prunus* which originated in the Caucasus and were budded with Czar in 1931.

The two year old apple trees composed of three varieties of "stem-builders" obtained from Germany and budded at three inches above ground-level on the rootstocks Nos. IX, XII and a race of seedlings, have been grafted at five feet above the union with commercial varieties, in order to measure the effect of a long piece of intermediate on the stock-scion relationship.

Two further series of apple trees have been "frameworked" in various ways and the methods used in 1933 were described (13). Further trials will be undertaken in the spring of 1935 with special reference to the occurrence of disease in certain apple varieties following top-grafting. The preparation of a series of plum trees having disease resistant frameworks has been continued in collaboration with the Mycology section and the heads of the trees are now ready to receive grafts of a susceptible variety.

Investigations into the technique of the propagation of rootstocks by means of layering and by hard- and soft-wood cuttings and root-cuttings have been continued in collaboration with the Physiology section.

The nursery technique studies continue; the trials of the effect of the presence or absence of wood in the bud shield have been extended from apples to pears, plums and cherries. Three differing types of rubber strip have been tested with a view to obtaining a suitable material for tying inserted buds.

Some thirty varieties of flowering cherries have been budded on to selected vegetatively propagated Mazzards (*P. avium*). Probable incompatibilities have appeared in the first season. Rootstocks such as are commonly used in Japan are being raised for budding with the same varieties.

(b) *Root development investigations.*

Direct observations on growing apple roots have been continued at weekly intervals by means of " observation trenches ", which have glass windows fixed against the soil, and protected from light (9). The roots of mature trees on two different rootstocks have now been under observation at East Malling for three years, and a third rootstock for four years. It is now possible to note the manner in which the fine absorbing rootlets spread in successive waves, " combing " the soil through and through. On account of the suberizing, shrinkage and, in the case of many of the finest roots, death and rotting away of the roots, the soil is left permeated by fine channels which must be of considerable importance in the drainage and aeration of the soil. Records of soil temperature and moisture have been obtained, and confirm previous findings as to the direct relationship between soil warmth and root growth, with sufficient moisture as a limiting factor.

In the latest type of observation trench, special arrangements have been made for the application of local treatments to selected roots. Lack of time has prevented full use of these devices at present, and for the same reason the projected study of the effect of grass roots on apple root growth has been postponed.

Soil moisture recorders.—The soil moisture recording instruments developed by the Station in the course of the above work are now being manufactured commercially. They have been further improved recently, but are still only suitable for permanent use on sandy and loamy soils.

A repetition of the trial (in root observation boxes) of effect of light on root growth has confirmed that a weekly exposure of 30 minutes is sufficient to cause a definite check to the root. Hence it is clearly desirable to keep the time of recording as brief as possible.

Some strawberry plants have been grown in root observation boxes, and it has been found possible to make observations on the root growth. The technique is not so easy as it is for apples, however, on account of the very numerous and fine roots of the strawberry plants. A preliminary trial of the development of " Root-rot " on these observation boxes is being carried out.

Tree excavations.—A study of the root systems of a comparable series of mature apple trees on the main types of rootstock on sand, loam and clay soils has been fully reported on (14). The root system of a 10-year-old Lane's Prince Albert apple tree on rootstock No. II excavated from a heavy clay soil has been reconstructed as a permanent exhibit in the gallery of the new grading shed.

(c) *Investigations in biennial bearing.*

Whilst there is evidence to show that with a markedly biennial bearing variety like Early Victoria, the year of bearing can be altered by removing the blossom, negative results have been obtained with certain other varieties, such as Lane's Prince Albert, where biennial bearing was not much in evidence, and even with Newton Wonder, where it was.

The investigations will be continued as opportunity offers.

(d) *Double-working of fruit trees.*

There are no further developments in this work at present.

(e) *Investigations into the non-setting of the blossom of certain varieties of pears.*

Observations were continued on the dehorned and top-grafted trees of Doyenne du Comice and on the spur-thinned trees of Marie Louise. A series of maiden trees consisting of Doyenne du Comice single worked, worked on itself, and on Glou Morceau, all on Quince A, were planted out and are being trained in single U. form, the first and second scion—where present—each forming one branch of the U. The object of this trial is primarily to test the empirical theory of "sap transfusion" from the intermediate to the second scion in its effect on blossom setting.

(f) *Pruning.*

Apples.—The least valuable of these trees have now been discarded, and weights of head, stem and root recorded. There are no other fresh developments at present.

Pears.—Experimental pruning treatments on the older series of pears which are now 13 years old are being continued. Heavy crops of fruit were harvested in 1934.

Differential methods of pruning the leaders of the nine varieties in the younger pruning trial, now five years old, have been commenced. The relative effects of hard and light leader tipping are being compared, firstly where a large number of leaders have been left and secondly where the number of leading shoots has been restricted.

The treatment of the laterals is being adapted to the needs of each variety, the methods being based on the experience gained in the older experiment.

Cherries.—The "dehorning" of alternate Morello trees has yielded encouraging results; growth following the hard cutting was excellent, and of 4 or 5 trees infected by *Stereum* all recovered except one. Cropping was not so long delayed as was expected.

(g) *Fruit thinning.*

Apples.—The experiments previously referred to are now being brought to a close.

(h) *Manuring.*

The experiments in the restoration of unmanured trees to good health and the combined use of grassing and manuring to obtain a suitable balance in the tree have been continued (8).

Though the effect of applications of potash and nitrogen to previously unmanured apple trees had been clearly shown in growth and health of foliage, manuring was continued for one more year in order to include another full crop in the period of experiment, and so complete the records on this aspect of the tree's response. With Bramley's Seedling, where colour is not required, a combination of potash and nitrogen gave better results than potash or nitrogen alone. With Worcester Pearmain, however, colour is of great importance, and potash alone gave the best results in that respect. Potash and nitrogen together gave slightly less colour than nitrogen alone, an effect probably due to the greater density of the foliage. For the first time symptoms of nitrogen deficiency became apparent and were most marked on the trees receiving potash only.

The plot of Bramley's Seedling under grass showed, even more markedly than in the previous year, the effect of a dressing of 5 cwt. per acre of nitro-chalk on the foliage, growth and colour of fruit. The primary effect of the grass was apparently to reduce spur foliage and growth of laterals, that of the leading shoots being less affected.

In the experiment in which Worcester Pearmain under grass had received 5 and 15 cwt. of nitro-chalk per acre in the previous year there was a carry-over of the effect of the heavy dressing. Though the trees which had received 15 cwt. in 1933 were given nothing in 1934 the fruit from those receiving 5 cwt. each year was again in most cases larger and had more and brighter colour, while with most stocks the 15 cwt. trees made more growth and bore denser and larger foliage.

In the trial designed to show the effect of nitrogen, potash and phosphate, alone and in combination, the young trees of Cox's Orange Pippin and Beauty of Bath have continued to show the marked effect of potash on growth and foliage. The Cox's bore their first crop of any size, and a flavour test showed that while potash alone was beneficial and nitrogen alone detrimental, both were beneficial when used in combination. With Beauty of Bath, the most marked effect was the delay in ripening where potash was given, possibly indirectly due to the denser foliage. The varying response of trees on different rootstocks to the same manurial treatment, already shown in their growth, was seen also in fruit quality.

The preliminary trial of application of nitrogen to young apple trees at 5 different times of year has not yet shown any striking differences.

Plums.—The pot culture experiments with the variety Victoria has been continued in collaboration with the Pathology section. Stem inoculations have been made this autumn.

(i) *Variety collections and trials.*

Apples.—Records have been continued on cordon apples and pears. Some new varieties have been added to the collection.

(j) *Fruit breeding.*

Rootstocks.—The work of raising new varieties of apple rootstock combining the qualities associated with good rootstocks with immunity to Woolly Aphis, undertaken conjointly with the John Innes Horticultural Institution, has consisted largely in the crossing together of pairs of immune varieties, including some lesser known immune varieties from the Dominions. The back crossing and intercrossing of selected immune seedlings has been continued.

Three immune seedlings (Spy × II) have been worked with Lane's Prince Albert and given a trial since 1930 (6). The trees made about twice as much wood growth, and gave half as many blossom buds, as trees on the dwarfing No. IX. The three are very similar. More extensive trials, including a fourth immune seedling, have been planted.

Several further families of seedlings have been raised from crosses between members of the " Paradise " rootstocks. Observations have been continued upon a number of families from crosses between No. IX and other members of this series. About forty of these seedlings have now been selected as worthy of further trial as rootstocks. With the object of gaining information as to the inheritance of rootstock influence in seedlings of known parentage, two entire families comprising approximately 180 seedlings have been planted out and worked with Lane's Prince Albert.

The initial trial containing nine selections from a family VIII × IX worked with Lane's Prince Albert in 1930 has been carefully studied (6). Trees on these selections showed very wide variations in wood growth; by their third year, trees on the least vigorous of them had made considerably less wood growth than comparable trees on No. IX, while trees on the most vigorous had made almost three times as much wood growth as those on No. IX. Trees on all the selections, however, were blossoming heavily by their third year, those on seven of the nine selections bearing more blossoms than the trees worked on No. IX. More comprehensive trials of these new seedlings are now in their first and second year.

A large number of "wilding" apple, pear and quince, raised from seed collected in the Caucasus and Turkestan are being tested as possible new rootstocks which may possess exceptional hardiness, disease resistance, etc. A number of pear seedlings from other sources are also being tested for ease of vegetative propagation.

In an attempt to combine ease of propagation by vegetative means with a wider range of influence over the scion, about 150 seedlings raised from crosses between several of the most widely used plum rootstocks are ready to be planted out. In the trial of young Czar plums worked on selected seedlings of *Prunus devaricata*, incompatibility was found to be comparatively rare. Wide variations in vigour at one year old occurred, however, between trees on the different selections (7).

Scion varieties and shortening the "juvenile period".—Further families of apple and pear seedlings have been raised in the search for valuable new varieties. Fresh crosses have been made in the hope of obtaining information on the inheritance of fruit colour in the apple. A number of crosses were made between varieties of the apple immune to woolly aphis and varieties of high commercial value in an endeavour to produce high quality immune varieties. These seedlings are being subjected to artificial inoculation tests.

A number of methods for hastening the fruiting of seedling apples are being investigated, including working upon precocious rootstocks, pruning, top grafting upon mature trees and growing in pots. About ten trees in a batch of apple seedlings, raised in 1929, growing on their own roots and worked on rootstocks Nos. IX and XII blossomed and fruited for the first time during the past year. All ten trees which fruited were worked upon No. IX. This confirms the previous observation of the value of a dwarfing and precocious rootstock for bringing seedling apples into blossoming and fruiting. The fruit from several of these trees possessed promising characteristics.

In a combined attempt to elucidate the causes of the unsatisfactory sets of fruit obtained on Doyenne du Comice pear, the blossom of trees on three types of quince, lightly and severely dehorned and overworked with Glou Morceau were once again pollinated with Glou Morceau and Conference. Little success in setting fruit was obtained with either in any of the series.

(k) *Pomological aspects of spraying.*

As opportunity offers, data are being collected on the effect of factors such as rootstock, manurial treatment, cropping and weather conditions on the incidence of spray-damage.

A field trial, started in 1933 to test the possibility of reducing lime-sulphur-injury by the use of ferrous-sulphate in the spray, was continued in 1934 (see " Spray-Injury Trial," page 92).

(l) *Marketing problems.*

The influence of such factors as variety, stock, pruning, thinning, cultural and manurial conditions on market value, is being carefully watched over a period of years.

(m) *Artificial irrigation of apple trees.*

The dry summer provided an opportunity for a repetition of an apple tree irrigation trial, similar to that carried out in 1932. Water equivalent to 9 inches of rain was applied by the furrow method to a row of 16 trees of Early Victoria and James Grieve in mid-June, and penetrated to a depth of 30 inches. The average size of fruit was slightly larger on the irrigated trees than on the unirrigated controls. The storage properties of the irrigated James Grieve fruit proved to be excellent, and equal to those of the non-irrigated fruit.

Moisture meters were installed at two depths in the irrigated and control rows, and have given some very interesting information concerning the spread of irrigation water and rain water, and the drying of the soil by the trees and by evaporation.

(n) *Walnuts.*

The main investigations on walnuts have now been terminated. Work is only continued as circumstances permit.

IN RELATION TO SMALL FRUITS.

(a) *Nomenclature, classification and variety trials.*

Black currants.—Crop records are being continued on the older series of black currants, in which are included representatives of the four main groups, in order to maintain the continuity of these records until the new trial planted on Newgates Field a year ago comes into cropping.

The trial of Baldwin and Wellington's Triple X at different distances, planted in 1932, bore its first crop this season. Partly owing to the closer planting of this variety Baldwin had a considerably higher acreage yield this year. Nevertheless the crop per bush of Triple X in this season was actually lower than that of Baldwin.

Red currants.—With the exception of one variety, La Constante, which bore about one pound per bush in 1933, the trial of clonal races of principal varieties of classified red currants bore its first considerable crop in 1934. Very marked differences in amount of fruit were observed, the fourteen varieties dividing up in to four broad groups.

The crops are however still small—at the most a little over a ton per acre—and do not at present give a reliable index of the true value of the varieties, some of the heavier cropping varieties being of little commercial value owing to the poor size of the fruit.

Other rubi.—Records are being continued on the blackberry and dewberry collection.

A small collection of " loganberries " from various sources with distinctive leaf or other characters has been planted. The different types will be carefully recorded and clones raised of any which give a particularly good performance.

(b) *Propagation and the establishment of clonal races.*

The clonal stool beds of blackberries, dewberries and loganberries have yielded a good supply of plants, some of which will be used for new trials and some for extending the stool beds.

Strawberries.

The establishment of virus free clones.—Our virus-free clonal race of Royal Sovereign has now reached sufficient numbers for large-scale propagation. Plans are completed for the laying down of two large runner beds in an isolated position on the Research Station, and three " daughter nurseries " at selected centres in Kent and Sussex, (see " yellow-edge virus " page 94). A virus-free clone of Tardive de Leopold now numbers about 1,000 plants. Clones of various other commercial varieties (including Paxton, Huxley, Mme. Lefebvre and Stirling Castle) and of several recommended strains of Royal Sovereign are being raised. When a sufficient number of plants is available, a new " clonal strain " trial will be carried out, possibly combined with a variety trial.

Individual plant studies of clonal families.—The tracing out of the life history of all the plants of six clonal families (of three strains) has been continued. Individual plant records of vigour, health and cropping have been obtained on these plants (which number some 800), from the time of their formation onwards. Their 3rd crop will be borne in 1935.

Similar individual plant records (including crop) have been obtained on a second " generation " of this trial, numbering some 1,200 plants. The object of these trials is to trace out the effect of time of origin, position on stolon, health and vigour of parent, etc., on the subsequent performance of the plants. Results to date seem to justify the conclusion that once it is established, every healthy runner has an equal chance. The small late-formed runners are, however, more liable to damage by adverse conditions following planting, and are more severely checked by the " warm water treatment " than are the larger runners.

Uniformity trials.—The second trial mentioned above has been planned as a " uniformity trial ", to obtain information on the ideal size and shape of plot.

Runner bed arrangement.—A trial of different ways of arranging the parent plants in the runner bed for virus free runner production has been continued. The method of laying the runners into small isolated blocks appears to give useful results.

Effect of runner production.—An extension of the above trial has made it possible to study the effect of runner production in the first year on vigour and cropping, and on runner production of the parent plants in subsequent years. The plants that produced runners in 1933 bore approximately half as much fruit in 1934 as plants that produced no runners in 1933.

Age of runner parent and spacing of runners.—A trial is in progress to determine what difference (if any) there is between the performance of (*a*) runners from one and two year old parents, and (*b*) runners that were spaced and unspaced in the runner bed. This trial has been planned so that three spraying treatments can be superimposed.

(c) *Planting, training, pruning, etc.*

Loganberries.

The existing loganberry training trial is being retained for one more year. The information gained from this trial will be very useful in planning a new loganberry and phenomenal berry trial, which will be planted this winter. The trial is designed to investigate the possibilities of controlling the cane-spot disease by spraying and/or training, and also to compare the pomological value of loganberry and phenomenal berry. Four methods of training are included, viz. Fan, with plants at 6 feet apart in the rows; one-way system with plants at 6 feet apart; one-way system with plants at 12 feet apart; and weaving, with plants at 12 feet apart. The trial is planned so that two spraying treatments can be given.

Strawberries.

Time of planting and warm water treatment.—A new time of planting trial has been commenced with warm water treated and untreated runners, to determine whether previous findings in regard to time of planting need to be modified when the further factor of warm water treatment is introduced. The effect of warm water treatment on runners of different sizes is also being studied.

Certain plants have been reserved for digging up in order to observe the effect of warm water treatment on the new root formation. Some idea of the initial check given by the treatment is thus being obtained.

Burning.—A preliminary test of the effect of burning the straw litter after cropping was carried out. Observations on the effect of this treatment on the plants and on pests are being made.

(d) *Manuring.*

Strawberries.—A trial to determine the effect of different distances of planting under four different soil fertility conditions is being prepared. The proposed manurial treatments are: Nil, Humus, N.P.K., Humus + N.P.K., and the spacings wide, medium and close.

One medium spaced plot in each block is to be duplicated for lifting and examination of root rot plants (see page 94). Crop, vigour and root rot records are to be taken on the rest for three or four years.

(e) *Fruit breeding.*

Black currants.—Final selections have been made from the seven year old seedlings (crosses between previously selected seedlings and commercial varieties) and the plot grubbed. The study of the seedlings from a new series of crosses was continued. The hybrid seedlings derived from crosses between the black currant, the gooseberry and *Ribes longeracemosum* were again completely sterile, although a considerable number of flowers were borne.

A number of seedlings obtained from seed subjected to X-ray treatment at the John Innes Horticultural Institution and derived from irradiated ovules and pollen, were planted out. They are being examined to discover whether the treatment has caused any mutations.

Red currants.—With the exception of one or two seedlings, all the red currant seedlings obtained from selfing the main varieties have proved to be decidedly inferior to commercial varieties, after seven years trial, and have been discarded.

Strawberries.—A number of crosses between seedlings immune and susceptible to " yellow-edge " disease, among the families Royal Sovereign × Sir Jos. Paxton and Lefebvre × Sir Jos. Paxton, were made, in order to determine whether resistance and susceptibility to this disease are controlled by genetic factors. Two apparently resistant seedlings of promise as commercial varieties were propagated in quantity and have been planted out for further trial. Breeding work with the object of obtaining new varieties of strawberry combining high quality with resistance to " yellow-edge " disease is being arranged.

Plants of about fifty seedlings, raised and selected at the Horticultural Research Station, Cambridge, were sent to this Station, during the Spring, for trial. The seedlings are already showing striking evidence of differential susceptibility to disease.

(f) *Fruit thinning.*

Gooseberries.—The experiments on these are for the present being discontinued.

STATISTICS AND RECORDS.

The analysis of the records on some of the newer trials continues to justify the more complex type of experiment. In particular, analyses of the results of the series of manurial trials on apples has yielded interesting results.

These experiments are of two types; a complex experiment involving the differential manuring of two varieties on different rootstocks from the start, and a simpler lay-out on established plantations of mature trees. In both types the statistical device known as the "analysis of covariance" has proved useful in interpreting the results in light of the previous history of the trees, either previous to planting or in the field (8).

Plot layout.—The uniformity trial of strawberries has yielded its first crop and the yields of some 1,460 plants were individually recorded. Upon these results has been based the layout of a number of trials to be planted during the ensuing year.

Plans have been drawn up for a complex cordon apple experiment and a comprehensive trial of loganberries, allowing for the possible superimposition of further series of treatments.

An experiment has been commenced to show seasonal effect upon certain nursery problems, such as incompatibility. This will be planted annually.

Records.—The work of the record office has not diminished. However, it is now possible to keep pace with the demand for easily digestible summaries, either for published reports or exhibits.

Technique of recording.—A very heavy crop has brought a new series of sampling problems. Sampling methods have now been devised for extension growth (on pruned and unpruned trees), time of blossoming, relative amount and set of blossom, size and colour of fruit, and are being tested as opportunity offers.

Work on the relationship between the various aspects of vigour in fruit trees has been confined to mere recording, but is now being continued and extended.

A new technique of weighing the fruit in the orchard has been introduced to cope with the increasing crops of our experimental trees as they reach maturity. The fruit from each large tree is now weighed in the orchard boxes (using a large spring balance) instead of in picking bags, so reducing considerably the number of weighings. This technique has proved very satisfactory. New metal sided picking buckets have been used, to overcome the bruising found in canvas picking bags: they have been fitted experimentally with automatic counters.

PHYSIOLOGY.

Vegetative Propagation.

(a) *Cuttings.*—Experiments on maintaining moisture conditions favourable for rooting, by use of humus layers, watering and shading, are being continued. Further experiments are in progress on the effects of etiolation, leaf removal and time and depth of planting. Cuttings of plum shoots off layers that had received different manurial and pruning treatments have been planted to determine whether these treatments have an after effect on rooting.

A trial of root cuttings of selected pear clones has been planted.

The course of root, leaf and stem growth in cuttings of a plum stock has been followed by the sampling method during 1934. Interesting results were obtained which are being followed up.

(b) *Layers.*—A large-scale investigation has been carried out on the effect of different manurial treatments and different times and types of summer pruning upon the development and rooting of shoots on layers of two varieties of plum stock. Hardwood cuttings have been taken from these shoots and planted as described above.

Leaf relations in apple trees.

The distribution of leaf surfaces.—Work is being continued on sampling methods for determining leaf surface on large trees, and for early detection during summer of growth responses to different treatments.

Carbohydrate relations.—Work on this line has been discontinued for the present.

Growth.

Seasonal course of root and shoot development.—A further paper on results obtained from the unworked apple stock No. XIII has been published (50). The total annual increment in weight was found to be distributed in approximately constant proportions between roots, stems and leaves, irrespective of the size or age of the tree. This explains how the constant stem/root ratio, found for trees of a given scion-stock combination on a given soil, is attained and maintained, and suggests a mechanism for some aspects of scion and stock effect on vigour.

The trees of the two scion varieties, each on four rootstocks planted last year, are being sampled according to plan. The results so far obtained indicate interesting differences in the leaf/root ratio on different rootstocks at mid-summer. Trees of six of these scion-stock combinations were grown in soil in glass-fronted root-boxes, and their root-stem and leaf growth recorded.

The experiment is to be repeated with a second series of trees that are being planted this winter.

Effect of scion on roots.—The morphological analysis of the trees mentioned in the last report has been begun.

Size of tree in relation to other measurements.—The results described in the last report have now been published (48). Work is in progress on the relation between the diameter of a tree or branch and the weight of the portion above the point where the diameter is taken.

Pruning.—The results described under this head in the last report have now been published (47).

Double working.—The results of an experiment on the relative importance of the stock root system and the stock stem in stock effect on the scion have been published (49). The material consisted of four series of double worked trees comprising the four possible combinations of two root systems (one dwarfing and one vigorous) and two intermediates (of the same variants as the root systems) with the same scion.

The results over a six year period confirmed the provisional conclusion, based on three years records, that the root system of vegetatively raised stocks is more important than stock stem in determining scion performance.

BIOCHEMISTRY.

Mutual influence of rootstock and scion.

(a) *Elementary analysis.*—Experiments have been continued to determine how far rootstock effect may be expressed in terms of the selective action of the roots etc. in absorbing elements from the soil and supplying them as raw materials to the scion; how far the effect of soil type may be expressed in terms of the elements extracted by trees from different soils; and consequently, in each case, how far these effects may be imitated by manuring, injection, etc., and how far seedlings with desirable qualities may be selected by chemical analysis.

The co-operation of a worker at the Imperial College of Science, London, has been obtained in an attempt to render the polarographic method suitable for routine use.

A new spectrographic method has been devised; preliminary results suggest that it has certain unique advantages.

(b) *Organic analysis.*—Work has been continued to determine how far rootstock effect etc. may be expressed in terms of organic compounds synthetized in the tree; how far such desirable effects as precocity, disease resistance, etc. may be imitated by injecting suitable organic compounds; how far seedlings with desirable qualities may be selected by chemical analysis, and how far varieties may be identified by chemical methods.

Causes of resistance to woolly aphis.—(See also page 96). Methods for extracting the constituents of bark and wood unchanged have been improved. After preliminary isolation of constituents the preparations are being sent to Professor R. Robinson of Oxford, for identification. It is hoped that from this collaboration will result a survey of the chemical constituents of fruit trees which should lead to a more accurate knowledge of their physiology and should facilitate future similar investigations.

Tree injection.

(a) *Distribution.*—Further difficulties have been encountered and overcome (44, 45). The methods evolved are being applied in many places overseas.

(b) *Avoidance of damage.*—As a result of the application of the principles previously worked out (46), no appreciable damage has followed any injections carried out this year.

(c) *Results of injection.*

(i) *Artificial Manures.*—The injection of Cox's Orange apple trees in a commercial plantation with a solution containing 0·25 per cent. dipotassium hydrogen phosphate plus 0·25 per cent. urea in June, led to marked improvement in foliage texture, an effect on fruit colour, an increase in size of fruit and of crop and in amount of wood growth.

(ii) *Iron salts for chlorosis.*—The nature of an extreme case of chlorosis in a valuable peach tree at the Swanley Horticultural College was diagnosed by small shoot-tip injections; and the scale of the injection was increased in two further stages until the whole tree was injected. A fortnight after the last injection, the whole tree had recovered its normal foliage colour. Although the fruitlets had remained stationary for weeks prior to the injection, afterwards they grew and nearly a full crop was eventually produced and marketed. Similar work has been commenced in a large commercial plantation of pears and apples similarly affected, with most encouraging preliminary results.

The injection methods have been simplified still further, so that the total cost of injecting a tree amounts to a few pence only.

PLANT PATHOLOGY.

MYCOLOGY AND BACTERIOLOGY.

Crown-gall.—An experiment was carried out in the greenhouse to test the effect of the application of sodium nitrate to young apple trees inoculated with the crown-gall organism *Bacterium tumefaciens*. More galls developed on the control trees than on those receiving nitrates, but the results were irregular and could not be regarded as significant.

Brown rot diseases of fruit trees.

In continuation of an experiment, during which it was ascertained that a shoot wilt in layer beds and stools of plum stocks was caused by *Sclerotinia cinerea*, one of the brown rot fungi, attempts were made to determine whether infection arose from the soil. No infection resulted from applying soil taken from pots in which the disease had been present the previous year.

Observations have been made on the incidence of fruit rot, caused by *Sclerotinia fructigena*, on plums in cold store.

Further observations on the stalk-end infection of apples by *S. fructigena* have been made and a note published pointing out that such infection may cause serious loss after the fruit has reached the market (16).

Bacterial diseases of fruit trees.

Bacterial canker of plum trees.—Experiments, in pot cultures and in field plots, are being continued to determine whether cultural conditions have any effect on the predisposition of trees to bacterial canker.

Field observations and experiments show that (*a*) pruning or cutting back plum trees in autumn is to be avoided as bacterial cankers may rise at the cut surfaces, (*b*) the variety Victoria when worked high (stem as stock) on Myrobolan B or Common Plum had a lower percentage of trees killed by bacterial canker than when worked low (stem Victoria), (*c*) on manurial plots, potash, applied to budded trees during the year the buds grew out, had no restraining effect on the incidence and development of bacterial canker on maiden trees (22).

Bacteriosis of cherry trees.—Organisms isolated from cherry leaves, branches and stems are being compared with each other and with the organisms causing shoot wilt (*Pseudomonas prunicola*) and bacterial canker (*Ps. mors-prunorum*) of plum trees.

Tests of bactericides.—Various bactericides are being tested *in vitro* on the bacterial canker organism to test their efficiency with a view to possible field trials.

"Fruit-russeting" and "branch-blister" disease.

A study of the effect of manurial treatment on russeting in Cox's Orange Pippin is under way.

Pure cultures of the associated fungus-types from a number of different sources have been grown and kept in stock, but no further inoculations have been made.

Further specimens of branch-blister have been received from various commercial sources, and all possible data are being obtained concerning them, in order to ascertain the relation of this disease to soil conditions.

Fungicide-insecticide trials.

Lime-sulphur again proved to be the most desirable agent of those tested for scab-control, whilst dusting with sulphur showed promise as an adjunct to spraying (20).

An account was published (24) of the first year's progress (1933) towards determining the relative efficiency of complete minimum spray-programmes of fungicide-contact insecticide washes on Cox's Orange Pippin for the simultaneous control of certain insect pests as well as of scab. Excellent control of scab and red spider was obtained by lime-sulphur in the very dry season experienced. Two pre-blossom sprays were not more beneficial than one. Derris and nicotine, respectively, with sulphite lye as wetter, were used in combination with lime-sulphur. Nicotine gave very good control of apple sawfly in the egg stage (a new point in the control of that pest), but derris was only half as effective in this respect. Certain brief suggestions for the control of apple sawfly, based on this work, were published (41).

This line of work was continued in 1934. Lime-sulphur was used as standard fungicide, together with lead arsenate pre-blossom and nicotine post-blossom as insecticides. Three different wetters were compared at petal-fall, but the classified results are not yet available.

Spreader trial.

Tests of the value (for the control of scab and certain insect pests) of different spreaders, in combination with lime-sulphur as standard fungicide and nicotine as standard insecticide, have been continued. These are still at a preliminary stage, as the tests are being made on young trees not yet in full cropping, but some promising results have been obtained.

Spray-injury trial.

Data have been obtained for a second year from tests designed to determine whether the injury caused by lime-sulphur and lead or calcium arsenate can be reduced through the inclusion of ferrous sulphate in the spray-mixture (see page 83). The trial will be continued, for the results to date are not sufficient to be conclusive.

Factors affecting susceptibility to apple scab.

Further data on the effect of rootstock and manurial treatment on susceptibility to scab in Bramley's Seedling, Worcester Pearmain and Cox's Orange Pippin were obtained during the year.

Apple scab in storage.

Observations have been made of apple scab on apples during storage (28). The lesions developing during storage are different in appearance from ordinary scab spots on fruit in the open, although caused by the same fungus. The larger lesions which develop in storage are sunken (saucer-shaped) and pitch black; such spots may develop fungal fructifications bearing spores. The smaller spots are lobed, more superficial and do not bear fungal pustules.

Apple canker.

In connection with the fungicide trials, records have been taken for a number of years on the incidence of apple canker (*Nectria galligena*) on Cox's Orange Pippin and Stirling Castle, each worked on a number of different rootstocks. These are summarized and published (25). Results showed that spraying for scab-control in this experiment had little, if any, effect on canker. The rootstocks, however, showed marked differences in inducing susceptibility in the scion, trees on No. XIII and on No. XVI being more prone to attack than those on other stocks.

The importance of cutting out all infected tissues was shown, but a trial of different materials for protecting wounds failed, owing to lack of infection in the wounds.

Raspberry mosaic disease.

Analysis of symptoms and varietal susceptibility.—The study of the North American virus diseases of raspberries in relation to those occurring in Great Britain has continued. By means of a grafting method, the leaf-curl disease and the mosaic disease commonly occurring in red, purple and black varieties of raspberry in North America were transmitted to virus-free plants of the English "index varieties" Lloyd George and Baumforth Seedling B and the two American varieties Cuthbert and Viking. The reaction of these diseases on the two former varieties was strikingly different from that of British raspberry mosaic similarly transmitted at East Malling. Observations on the incidence of virus disease on local American varieties of raspberry and on imported English varieties (Lloyd George in particular) were also made in the Niagara Peninsula and in other districts throughout North-Eastern America; these were subsequently extended to British Columbia. This widespread survey of raspberry virus disease in North America in conjunction with the results of the experiments at the St. Catharines laboratory confirmed the probable non-occurrence of American leaf-curl in Great Britain, and indicated a possible distinction between the analogous mosaic diseases in the two countries. The investigation is being continued in collaboration with the Dominion Laboratory of Plant Pathology at St. Catharines, Ontario.

Experiments in commercial control.—Further inspections of the Research Station nursery (for the propagation of virus-free canes) now in its seventh year, and of the five extension (Lloyd George) nurseries, now in their fourth year, were made with satisfactory results, no additional cases of infection being found in the former and only eight definite cases in the latter.

Initial surveys of a fruiting plantation planted in 1933 with Lloyd George cane obtained from Scotland (Blairgowrie district) and from each of three of the above extension cane-nurseries showed a very low percentage of definite cases of mosaic on the stools from each of these sources, those from Scotland showing a markedly higher percentage ($1\frac{1}{2}$ per cent.) than those from the extension nurseries (0·05 per cent.).

Loganberry cane-spot.

Experiments in the control of this disease were continued and yielded promising results as follows :—

(i) *Spraying experiments.*—A measurable degree of control of the leaf-spot phase was obtained by an application of a lime-sulphur spray either immediately before the blossom period or (in combination with derris for beetle control) at the standard time for beetle control. The most satisfactory results obtained hitherto in these experiments resulted by spraying at both these stages.

(ii) *Modified training.*—As in the previous season a marked degree of control was obtained by the use of certain modified training methods as compared with those in general use by growers. A long period experiment is being planned to determine, among other issues, the cumulative effect on cropping of each of the above methods alone and in combination.

Virus diseases of strawberries.

The relation between virus diseases and degeneration in strawberries has been summarized and previous work reviewed (18).

" Yellow-edge " disease of the strawberry.

During the year the study of virus diseases of the strawberry in Eastern Canada and U.S.A. in relation to the above disease was continued.

By the use of a grafting technique the disease occurring on varieties grown on the Niagara Peninsula and closely analagous to the Xanthosis disease in California was transferred to virus-free Royal Sovereign plants. The symptoms which developed on these plants were indistinguishable macroscopically from those occurring on plants of this variety infected with the " yellow-edge " disease in Great Britain.

Further results of these experiments indicated the necessity for testing material used in the study of the " root-rot " complex for freedom from virus factors and this aspect of the investigation is being continued in collaboration with the Dominion Laboratory of Plant Pathology at St. Catharines, Ontario.

Root-rot of strawberries.

Work on this disease, initiated in 1933, was continued in 1934 (19, 23, 29). The root-rot disease is characterized by a general dwarfing and flattening of the plants, without the yellowing or distortion associated with mite or aphid attack and " yellow-edge " disease. The roots show black lesions, and various fungi have been isolated from such lesions. These fungi have been used in inoculation experiments and five of them have been found to induce root-rot in pot experiments, viz., *Coniothyrium Fuckelii* Sacc., *Hainesia Lythri* (Desm.) v. Höln., *Cylindrocarpon radicicola* Wr., *Fusarium orthoceras* App. & Wr., and *Pachybasium candidum* Sacc.

Walnut graft disease.

Further work has been carried out on this disease and the fungus associated with it. The morphology and cultural characters of the fungus isolated from diseased grafts have been studied and compared with those of other strains isolated from a walnut root, carrot, and peach seedling. Certain differences under cultural conditions have been noticed. The value of formalin in reducing the incidence of the disease has been proved.

Intumescences on vine leaves.

It was found that intumescences or oedema of vine leaves occur when the atmosphere of the greenhouse is kept too moist, or when the roots are too active, as might happen in a moist warm soil (26).

Tomato virus diseases.

In collaboration with workers at the Research Stations at Cheshunt and Harpenden, experiments have been carried out for comparing the symptoms induced on tomato plants by inoculating them with certain English and Canadian viruses.

ENTOMOLOGY.

Observations on the life-cycle of the fruit tree red spider.

Investigations were commenced to determine the correlation of the hatching period of the nymphs of the fruit tree red spider from their winter eggs with the blossom period of apples and plums.

On certain varieties of apples it was found that a majority of the nymphs had hatched by petal fall, and since summer eggs were not laid until about a week later, a whole week elapsed when the egg stage was not present at all.

It was observed that only a small percentage of the mites had hatched from their winter eggs when certain varieties of apples were in the " pink-bud " stage, a factor which might reasonably account for the failure of the pre-blossom lime-sulphur scab sprays to control the mite in 1934, since it is known that the lime-sulphur spray does not affect the egg.

Resistance of apple seedlings to woolly aphis attack.

During 1934, 1,015 seedlings were tested for immunity to woolly aphis. Four hundred and fifty-five, of which 243 were raised at the John Innes Horticultural Institution, had already survived inoculation with aphides for one year. Of these, 278 remained immune and have now been handed over for pomological tests. The highest degree of immunity was found in the group Long Ashton OF5 × Northern Spy 46.7 per cent. immune. Northern Spy × Zuccamalio's Reinette gave 40 per cent. immune seedlings.

Of the 560 one year old seedlings tested, 243 remained resistant and will be tested for a further year.

Of the young trees tested, the varieties Curtland, Early McIntosh, and Alsopps Early were found to be susceptible, Lady Carrington, Macoun and Red Spy were immune, and of the two trees of Kirk's variety one was susceptible and the other resistant.

Causes of immunity.

Work has progressed along lines similar to those followed last year. The results obtained showed that the cause of immunity or susceptibility is not extracted except in small amount by alcohol, ether or boiling water and that after successive extractions with these three solvents most of it remains in the residue. They also suggest that it is amongst compounds of the cellulose-pectin type that the " cause " must be sought.

Apple sawfly.

Field spraying and dusting trials carried out in 1934 confirmed the previous season's findings (38, 40) with regard to the vulnerability of the several stages of the pest.

Apple blossom weevil.

Tests of dusts as a means of preventing oviposition were continued. Although a derris dust again (35) gave promising results, it was clear that weather conditions impose a limit to the degree of control which can be obtained with it. A barium silicofluoride dust was ineffective.

Impregnation of corrugated cardboard bands.

Investigations were continued to ascertain whether the apple blossom weevil and the codlin moth larva can be induced to shelter in chemically treated corrugated cardboard bands, which will in time destroy them.

One treatment actually appears to be an attractant to the weevil, since double the number were present in the bands of this treatment, as compared with those contained in the control bands. Other treatments also proved to be very promising, therefore, it is proposed to continue the experiment on a field scale next year. None of the treatments caused any injury to the trunks of the trees, and the destruction frequently caused to the bands by birds and mice proved to be negligible.

Apple fruit tortricids.

Further observations have been made on the life-cycle of the apple surface eating fruit tortricid (*Cacoecia podana* Scop.). Under natural conditions the oviposition period extends throughout the month of June. The larvae were noted to hatch from the egg masses which are deposited on the upper surfaces of the leaves, from the 18th June until 7th July.

Several other species of tortricids were also noted to be common in the spring, and at least two species may prove to be as important as *C. podana* Scop. The life-cycles of these species are under investigation.

Tests of derris and barium silicofluoride sprays and dusts were carried out and (in the case of derris at any rate) showed sufficient promise to justify further trials.

Systematic study of gall mites.

A systematic study of gall mites which infest plants is being continued, and material has been received from Great Britain, South India, United States of America, and the Sudan. Several species have not yet been described. The English species proves to be a new one. It is contained in the family *Callyntrotus*, which hitherto had not been represented in this country.

Tarsonemid mites.

A collection of species of mites of the genus *Tarsonemus* which infest cultivated plants is being made, and material has been received from Great Britain, Canada, United States of America, and the Sudan. It is proposed to study the group in detail when sufficient material is available.

The strawberry tarsonemid mite.

Further investigations upon the control of the strawberry tarsonemid mite have been carried out, the details of which have been published (32). The migratory habits of the mites are being studied, and it has been found that runner plants, which have been rendered mite free by the warm water treatment, become infested again in the first year of planting if they are planted adjacent to an existing mite infested field. It is desirable to isolate young plants, therefore, in order to keep them mite free.

Further modifications in the practice of the warm water treatment have been made, and it has been found that the success of the treatment depends largely upon the weather conditions at the time of planting.

Strawberry "yellow-edge" disease.

Experiments have been continued to determine whether the strawberry aphis (*C. fragariae* Theo.) and the strawberry tarsonemid mite (*T. fragariae* Zimm.) are vectors of the virus. This season's work proves conclusively that the strawberry aphis is a vector of the virus. Experiments with the strawberry tarsonemid mite have given negative results.

In view of the importance of the aphis, a study of its life-cycle is being investigated. Under glasshouse conditions five alternative host plants have been found, but the aphis has not been recorded from these hosts in the field.

Experiments on the control of the aphis are also being investigated.

During the year a general review of the damage done by insects and mites to strawberry plants was undertaken.

Blackberry mites.

A study is being made upon certain mites which occur on cultivated blackberries and closely allied plants. The possible association of mites with the condition of the ripening fruits described as "redberry" disease is also being made.

Raspberry and loganberry beetle.

In a trial carried out on raspberries, derris dusts were somewhat less efficient than derris and soap as a means of control.

A preliminary trial was carried out on loganberries with the object of controlling both loganberry beetle and cane spot with a combination spray containing derris. A good control of the beetle and a measurable degree of control of cane spot were obtained.

Small scale trials confirmed last season's finding (39) that the pest can be controlled on blackberries by a single spraying of derris and soap.

Raspberry shoot moth.

Experiments carried out in 1933-1934 showed that a complete control of this pest can be obtained, at the sacrifice of a year's crop, by cutting down the fruiting cane in the spring.

Derris.

In addition to the main field trials of derris in connection with apple sawfly, apple blossom weevil, apple tortricids and raspberry beetle. Work on the correlation of the toxicity of derris with its chemical properties has been continued in collaboration with Rothamsted Experimental Station.

The testing of insecticides.

Methods have been worked out for the laboratory testing of potential insecticides and spray auxiliaries. The phytocidal effects of the more promising of the materials so tested have been studied in the field by methods worked out during the past two seasons.

HOPS.

Cultural trials.—A progress report of the training and distance trial with the seedling L 21 has been published (51). The data so far obtained show that the yield per acre is greatly increased by closer planting, though the yield per hill is increased by wider spacing. The number of bines per string has had less effect on the cropping than the distance between the hills, but two bines per string has given heavier crops than one bine per string. The size of the cones and consequent quality of the crop may be materially affected by the treatments in certain seasons.

The experimental plot of the seedling OP 21, which has now been named "Brewers Favourite", has had the crop recorded for the first time. Owing to adverse weather conditions in the early summer and consequent scarcity of bine, the differential pulling treatments were not put into operation. The results obtained from the two distances of planting were, however, significantly in favour of closer spacing.

The trials with Fuggles (three strains and severity of cutting) and the seedling OV 7 (number of bines per string) were not sufficiently established for crop records to be taken.

Sufficient material is now available for planting trial plots of the seedlings P 13 (distance and pulling) and OO 63 (time of cutting and pulling)

Distribution of new varieties—Favourable reports have been received of the two experimental half acres of Brewers Favourite (OP 21) planted on farms in the Kentish Weald and Herefordshire last season. The variety appears to have had fewer failures and to have withstood the drought better than Fuggles on the same land.

This season over 6,000 sets of Brewers Favourite are being distributed to growers.

New seedlings (52).—Ten varieties have been grubbed and their place taken by twelve new seedlings. The crop from 250 seedlings was dried separately for cropping records, and bottle samples of the dried hops for analysis were taken from 97 varieties. The crop from fifty seedlings was pressed separately in part pockets for use in brewing trials.

The analysis of the 1932 crop again proved C 9a, which has been named "Brewers Gold", to have a greater preservative value than any other hop, English or foreign.

Among the midseason varieties, eight were higher in preservative value than the highest commercial variety (Fuggles). In the late hops thirty-seven varieties exceeded the best commercial variety (Canterbury Golding), one of which was "Brewers Favourite". Another late variety which appears to have a commercial future is 00 63, with the very high preservative value of 12.18 and has proved to be suitable for brewing pale ales.

Among the others are several varieties of the Manitoba and New Mexican class which are very heavy croppers and are suitable for stouts, with a preservative value equal to or exceeding the best American hops.

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POMOLOGY.

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15. HORTICULTURAL RESEARCH STATION, CAMBRIDGE UNIVERSITY

Plant Breeding.

Work has been continued with broccoli, brussels sprouts, cauliflower, peas and onions. Owing partly to the lack of interest shown by growers, and partly to the fact that it is no longer possible to cope with an extended list of crops, work on gherkins, cabbage, canning beans, canning peas, parsnips and silver skin onions has been suspended. It happens that the three important brassica crops, brussels sprouts, cauliflower and broccoli are the three to which the plant breeder's attention can be most usefully given. Onions have, temporarily at any rate, ceased to be an important market garden crop ; stocks bred at the Station are being maintained and some work is in progress concerning the inheritance of certain characters of commercial importance, but it is no longer thought advisable to devote to this crop the attention it received when it was still of some importance.

Peas remain an important market garden crop, and since several useful varieties have been bred at the Station, investigations concerning the relative value and suitability for commercial conditions of these varieties are being continued. The two successive drought years of 1933 and 1934 have, however, rendered pea growing almost an impossibility on the gravel soil of the Station. On the other hand, valuable information concerning the drought resisting capacity of the different stocks has been gained.

Since the object of the plant breeding work is the distribution to growers of seed or plants of improved varieties of vegetables, a method has been evolved whereby distribution on a limited scale in a particular area may be brought about in the case of Brussels sprouts, broccoli and cauliflower. Where sufficient interest is shown in a county, trials of Cambridge-bred material are held, under the supervision of the County Organiser. Information is thus obtained concerning the behaviour of the various stocks in that county. Particular varieties approved by growers are then grown on a larger scale, plants selected for breeding purposes, and a stock of seed obtained for distribution. (It is hoped that distribution will be possible in 1936 on a limited scale.) Distribution will take place through the Organiser, under certain conditions designed to prevent the stocks being exploited by unauthorised persons.

By this method it is also possible to continue the work of improvement from year to year.

Hitherto these trials have been rendered feasible by the help of growers, who have provided land and labour, receiving in return the produce of plants not required for breeding purposes. Unfortunately the fact that it is seldom possible to select the best plants in advance of the time when the grower wishes to harvest the crop has placed a serious obstacle in the way of selection. In future it is proposed to pay for the growing of the crop so that it will be at the disposal of the Research Station.

Broccoli.—Work is being carried out with two varieties of broccoli namely Roscoff and Derbyshire. The former is at present only of importance in the South and South-West of this country. Strains are, however, being evolved which it is hoped will enable the culture of this vegetable to be extended to districts where ordinary Roscoff broccoli is not hardy. This work has unfortunately been seriously hampered by the unfavourable weather conditions of 1933 and 1934.

Owing to the severe drought of 1933, the trial of broccoli at Hayling Island was a partial failure and the plants were unable to show their true character. For this reason only a small selection was made for breeding purposes.

The Derbyshire strains of broccoli have only been under investigation since 1932 (selected plants were first seeded in 1933). The strains in question are far superior to any other late broccoli hitherto tested at the Station (excepting the Roscoff variety, which is not hardy), and it will no doubt be possible to evolve from them a variety (or varieties) which will be of value to growers.

Brussels sprouts.—In spite of the adverse weather conditions of 1933 useful results were obtained from the trial (4 acres) held on Slate Hall farm. Since no picking was done before Christmas, an opportunity was afforded to test the relative hardiness of the various stocks on trial.

At the present time the trials are distributed as follows: Norfolk, 2 acres; Suffolk, 4 acres (2 centres); Bedfordshire, 4 acres (2 centres); Cambridgeshire, 2 acres.

It should be mentioned that in addition to the large-scale work subsequent to trials, breeding operations are carried out under glass with special plants. With sprouts the ordinary method of mass selection does not succeed in eliminating undesirable types nor in establishing a high degree of uniformity, even after so long a period as 40 years. A great deal of preliminary work is needed before this method can be safely adopted.

A technique has been evolved for self-fertilising Brussels sprouts, which normally are self sterile, and attempts will be made to investigate the genetic constitution of certain types of plant which are commercially desirable.

The National Institute of Agricultural Botany tested one of the Cambridge stocks (No. 31/43) against a commercial variety. The main object of this experiment was to investigate the possibility of applying statistical methods of analysis to the results of a Brussels sprout trial in so far as yield is concerned. The trial was satisfactory, and incidentally No. 31/43 proved to be significantly better than the standard commercial variety in yield. It was also superior in quality.

Cauliflower.—A further trial was made of stock No. 7 (which originated from a single plant in 1929). This stock has proved to be suitable for sowing in the autumn, in February (under glass), and during the spring months out-doors. The trial this year exhibited a high degree of uniformity and quality, and was in addition (as in previous years) markedly drought resistant.

CHEMISTRY.

Work on the physico-chemical properties of spray fluids has been continued.

The experiments on the keeping quality of different varieties of onions have been completed, and the results are now being subjected to statistical examination.

Experiments on the manuring of vegetable crops and on the manuring of vegetable crops for the purpose of increasing resistance to disease have been commenced.

MYCOLOGY.

Club-root of Brassicae.—Much of the mycologist's time has been occupied with investigation of the factors influencing infection of *Brassicae* with club-root. Most of the experiments were carried out in seed-boxes in an unheated greenhouse, the main factors investigated being as follows :—

(i) The acidity of the soil;

(ii) the quantity of inoculum present;

(iii) the time of application of the inoculum; whether before sowing or when the plants were 1-2 cm. high;

(iv) the age of the spores used as inoculum: spores from freshly formed young clubs were compared with those from clubs formed in the previous season. The old clubs were allowed to rot down in soil which was kept moist throughout the winter;

(v) the age of the host plants;

(vi) different types of soil;

(vii) temperature and " season ";

(viii) the effect of previous crops of *Brassicae*, with especial reference to their effect on the pH of the soil;

(ix) the nitrogen content of the soil; and

(x) the nature of the host plant: comparison of the susceptibility of Brussels sprouts (2 strains), kohlrabi and Chinese cabbage.

Experiments have also been carried out on the control of the disease both in seed-box and field trials. The seed-box experiments included work with compounds of mercury. Methyl mercuric chloride was tested at various concentrations. A marked reduction of the disease was affected at 1 in 10,000 but there seemed some evidence that the incidence of club-root was increased rather than diminished when concentrations varying from 1 in 100,000 to

1 in 1,000,000 were used. Four proprietary organic compounds were tested against one another and against mercuric chloride. All reduced the disease considerably, but there was no significant difference in efficacy between the proprietary compounds, while mercuric chloride at 1 in 500 was equally effective.

Experiments were carried out to test the statements made by Rochlin that black mustard (*B. nigra*) is resistant to club-root and that an extract of the seeds of this plant controlled the disease when watered on to the soil. In addition, a crop of black mustard was buried in infected soil to see whether this process reduced the amount of club-root in Brussels sprouts subsequently sown.

Black mustard, however, proved susceptible to club-root, though less so than Brussels sprouts. The presence in infected soil of a buried black mustard crop did not reduce the disease in the following Brussels sprouts, nor did preparations made from black mustard seeds, extracted both with cold water and with steam, control the disease.

An attempt was made to determine whether the reduction in club-root due to liming results from an actual killing of the spores of *Plasmodiophora* or merely from their temporary inactivation.

Plants grown in infected soil treated with lime and subsequently re-acidified did not become diseased. In this experiment, therefore, the inactivation persisted for some time at least after the removal of the lime from the soil. The absence of infection cannot be attributed to the effects on the spores of the re-acidification. This experiment is still in progress.

The field trial commenced in 1933 is still in progress. No further chemicals have been applied. Preliminary examination of some of the plants shows that, presumably owing to the abnormally dry seasons of 1933 and 1934, there is practically no disease even in the untreated plots.

At St. Neots a field trial to compare the control of club-root effected by the use of sulphur, cyanamide, mercuric chloride and a proprietary compound has been started. Each substance is being tested by itself and in the presence of lime. No results are yet available.

Experiments were also carried out in uninfected soil to determine the effect on the growth of *Brassicae* of chemical treatments of the soil likely to be of use against club-root. The questions investigated were as follows:—(i) The subsequent growth, in an untreated soil, of Brussels sprout plants from seed boxes treated with various concentrations of mercuric chloride; (ii) the effect of seed-bed treatment with 1 in 1,000 mercuric chloride and of "puddling-in" with a similar solution. The effects of each treatment separately and of the two combined were examined; and (iii) the comparative effect of mercuric oxide, mercuric chloride, lime and mercuric chloride + lime.

The results of these experiments are being subjected to statistical analysis.

Ring-spot of lettuce (*Marssonina panattoniana*).—Preliminary inoculation experiments with *M. panattoniana* on lettuce indicated that plants grown in soil treated with phosphate or potash were less severely damaged by the disease than plants grown in untreated soil or in soil treated with nitrogen.

Attempts are being made to determine the possibility of seed-transmission of this disease; the effects of seed treatments on the growth of lettuce and on the incidence of ring-spot are also under investigation.

ENTOMOLOGY.

Cabbage aphis (*brevicoryne brassicae*).—An investigation upon the cabbage aphis was commenced in November, 1933. The main objects in view were to determine how the aphis passed the winter and how it reached the young crop in the spring; the cycle of infestation; and possible methods of control.

In connection with the investigation a survey in the Eastern Counties was undertaken. In November, 1933, there were still a few winged aphids alive and very great numbers of wingless forms and eggs. Eggs at this season were very easy to handle. During the later part of December and onwards eggs burst very easily. In January all winged forms had died and wingless ones were rapidly decreasing. On February 1st, 1934, the last wingless forms were found, and from thence to the beginning of April only eggs could be found. On April 10th, 1934, the first young aphids hatched from the over-wintered eggs were seen. From that date until May 24th very small colonies varying in numbers from a single individual to six wingless aphids were to be found here and there in all districts. These colonies were not upon the leaves but among the flower buds of *brassicae* which had been allowed to grow up for seed.

On May 24th a very bad attack was discovered near Gamlingay in which over 90 per cent. of the cabbage plants allowed to run to seed upon a deserted small-holding were badly infested, the upper parts of the flower stalks being smothered with wingless aphids, amongst which were many winged forms—the first seen in 1934.

On June 7th winged aphids were observed on the move above the *brassicae* upon which they had bred. On June 18th the first migration of winged aphids to the new crop was observed.

During July, August, and September the infestation increased in intensity on all forms of *brassicae*. The apex of the infestation was reached during September.

From April to October certain Hymenopterous parasites, the larvae of several species of syrphid flies, and ladybird beetles and their larvae were very active. These and some heavy rain showers very markedly decreased the infestation so that in October 1934 it was not possible to find plants as smothered with aphid as were seen in November 1933.

The first eggs were found on September 29th, 1934.

Of the controlling agents used, nicotine and soft soap emulsion was found to be the most immediate and sure in action, although light derris dust may be easier to use upon *brassicae* in July when the amount of foliage is considerable.

The following possible control measures are suggested :—

(i) Plants grown for seed should be sprayed with ·05 per cent. nicotine and soft soap emulsion during April and May to kill hatched aphids among buds and flowers and upon pods at the later end of the period.

(ii) During June and July dusting infected plants (if spraying be found impossible) with 3 per cent. nicotine dust before the amount of foliage has become too great, may arrest the attack.

Hymenopterous parasites developing within the aphids are unaffected by nicotine spray or dust.

The cabbage root fly (*Chortophila brassicae*).—Experiments with attractants begun in 1932 have been continued. The following substances were tried :—Yeast, allyl mustard oil, glycine 2½ per cent., glycerol 10 per cent., hexachlorethane. Six balloon fly-traps were baited with each substance and set out among the crop at intervals of 12 yards (30 baited traps). An unbaited trap was placed near each baited one as a control. A number of female cabbage root flies were taken before they had laid their eggs. Yeast was again found to be most attractive to the flies and was followed by allyl mustard oil and glycine 2½ per cent.

Titles of papers issued during the year.

1. Woodman, R. M.: Wetting, spreading and emulsifying agents for use with spray fluids. VI. The effect of varying proportions of water and aid to dissolution on miscible oil formation and on the character of the emulsions subsequently formed from these miscible oils. *J. Soc. Chem. Ind.*, **52**, 351T, 1933.
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16. EXPERIMENTAL AND RESEARCH STATION, CHESHUNT

MANURIAL AND CROP MANAGEMENT TRIALS.

Tomatoes.

Manurial and crop management trials with tomatoes have been continued. Past experiments have shown that the tomato crop in the experimental houses is not improved either in weight or quality by the addition of phosphate but it was considered advisable to arrange a new experiment which would be suitable for statistical examination, and would decide finally the value of phosphate to this crop. This was conducted with the co-operation of the statistical department of Rothamsted Experimental Station and the results showed that the omission of phosphate for one year was without effect upon the crop.

The improvement of glasshouse soils by the process of placing clean straw in a vertical position in the soil was tested further. In a house where straw had been applied to the soil for 1933, the treatment was repeated on one side while the other side was steamed. The crop from the soil to which straw had been added during two years was considerably higher than that during the year previous to the first application, but there was no marked improvement over last year, whereas the crop from the steamed soil, approximately 47 tons per acre, showed a considerable increase.

The results of this experiment and of several others on commercial nurseries suggest that the effect of steam sterilization could be improved by applying clean straw to the soil in a vertical position prior to turning on the steam. This will be tested during 1935.

The variety trials showed again that hot sunny summers are favourable to the types Kondine Red and Radio, for as during last year these come near to the top of the list. A new type, " J.H.", gave the highest yield of 48 tons per acre, being followed by Radio with 44 tons per acre and various Kondine Red types.

The F_1 generations of several new crosses were grown. The parents were selected carefully as being likely to yield new types combining earliness with heavy crops of high quality fruit.

A large experiment was conducted to test the commercial possibilities of the process of warming the soil by circulating hot water through narrow pipes buried some two feet below the surface. Previous results were confirmed by way of heavier crops and both cleaner and more extensive root development, but the percentage increase was not so great as in previous years. This may be due to the fact that the natural soil temperature was 7°F. above the usual temperature during the early part of the season. The experiment showed that the process of soil warming is likely to prove of the utmost value in commercial work for it ensures a uniform and healthy crop even in soil which has previously failed to react to any treatment except steam sterilization. Indeed soil warming may ultimately replace steam sterilization to some extent.

A new experiment was arranged to test the effect of mixing fertilisers with the subsoil as well as the surface soil, but no improvement was obtained. Examination of the roots at the end of the season showed little development in the subsoil owing apparently to bad physical conditions and it is considered advisable to postpone any further experiments on this problem until it is possible to devise means for improving the physical state of the soil to the necessary depth.

The effect of overhead damping was examined further and it was shown that heavier crops result from continuing the damping process throughout the whole season. The reason for this is that during the height of the summer the atmosphere in the houses is too hot and too dry for satisfactory fertilisation of the flowers.

Cucumbers.

The cucumber experiments were concerned with the effect of raising the bed temperature either by means of electrically heated wires or by circulating hot water through narrow pipes buried under the beds. Only in one case did the heated bed yield a heavier crop than the control, but this is so different from previous results that some other influence is assumed to have masked the effect of soil warming. As in the tomato houses, the natural soil temperature was abnormally high and therefore the conditions in the beds were more suitable for satisfactory root development than is usually the case. Further the bed temperatures were thermostatically controlled during the period of heating, whereas during previous years, the beds have been heated only during the night. The relative effect of warming the beds during the day and during the night will be examined in 1935.

Lettuce.

The selection of Cheshunt Early Giant lettuce is being continued. An excellent crop of well-hearted lettuce was produced for the Christmas market, and this variety is maintaining its earlier promise, for it produces large firm hearts during the short days of the year.

Experiments with the Iron Fireman type of automatic stoker were continued. The apparatus, which uses a cheap form of soft coal has shown an appreciable saving in fuel consumption, and being controlled thermostatically it provides a more uniform temperature in the houses than can be obtained by hand firing.

PESTS AND DISEASES.

An investigation into the economic status of the greenhouse symphilid (*Scutigerella immaculata* Newp.) in relation to the tomato plant indicates that the symphilid is not responsible for injury to the roots of the tomato plant.

The parasite (*Comedo opaculus* Thoms.) was successfully carried over the winter in the pupal stage, and was bred up to the end of July. Owing to the poor adaptation of this parasite to its host, the tomato moth caterpillar, the project of distributing it has been abandoned.

In May, some lady-birds (*Stethorus punctillum* W.S.) known to be predatory upon the red-spider mite were received from Belgium. They were successfully reared during June, but the stock died out during the heat of the late summer. It is unlikely that this insect would adapt itself to temperatures obtaining in a tomato house.

Extensive experiments were carried out with cuprous cyanide as a substitute for paris green in woodlouse baits, Owing to the decomposition of the former compound when mixed with bran and dried blood, the results obtained in glasshouses proved inferior to those obtained with paris green.

Suspensions of lead arsenate, cryolite and finely divided cuprous cyanide were respectively tested as sprays with a view to the control of tomato-moth caterpillar (*Polia oleracea* L.). Cryolite again proved a satisfactory substitute for lead arsenate, while cuprous cyanide gave results similar to the latter. The uncertainty as to the poisonous nature of cuprous cyanide precluded any recommendation as to the advisability of its use for this purpose.

A glasshouse of 3,000 cubic feet capacity, containing soft-grown tomato plants in large pots has been fumigated with hydrocyanic acid gas according to Collinge's formula 1912. The plants were in no way injured and the economic possibilities of this treatment will be pursued in the near future.

In connection with the investigation of leafy gall of the chrysanthemum, an attempt has been made to clean infected stocks by systematic propagation from healthy plants only. Some improvement has been noted but the results are not entirely conclusive.

The investigation of rose diseases has been continued. Infection by *Coniothyrium rosarum* has been proved in numerous plants which have died on rose nurseries during the past season, and there is no doubt that this fungus is responsible for a great deal of damage. The work is being continued.

Experiments with rose rust have provided some evidence to show the existence of different strains on different species. Thus a strain from *R. rugosa* will infect the cultivated rose, but not *R. laxa*, while a strain from *R. canina* and *R. laxa* has not yet been found to infect the rose. This aspect of the disease is being investigated in greater detail. In a series of experiments lasting from October 1933 to July 1934 germination of the teleutospores was not obtained.

Experiments with oil in copper emulsions for the control of rose rust have been continued but satisfactory control of the disease has not been obtained without damage to foliage.

The cyclamen is being cultivated more extensively each year, and from the number of enquiries received it is clear that attack by eelworm is increasing rapidly. Many substances have been tested as a soil drench but so far without success. Owing to the seriousness of this pest growers are advised to cultivate this crop only in sterilized soil.

For many years growers of winter cherry *Solanum capsicastrum* have experienced serious losses and many have ceased to cultivate it for this reason. The problem came under close investigation during the past season, when it was found that on one nursery about 40 per cent. of the plants were attacked by *Phytophthora* sp. Other cases suggest that this fungus is largely responsible for the serious losses in the past. Control can only be obtained by cultivation in clean or sterilized soil, using a clean water supply.

A serious disease of cultivated heaths *Erica hyemalis* and *Erica nivalis* has also been traced to infection by a *Phytophthora*, probably *P. syringae*. This is probably the same disease which, at frequent intervals, descends upon this crop, and a full investigation is being made.

As the result of prolonged investigation it is now possible to recommend a method for sterilizing lettuce seeds, which can be used by the commercial grower.

Preliminary work on the " vernalization " of lettuce seed has suggested that the temperature of germination may be an important factor in the subsequent life of the plant.

Collections of fungi, mainly *Fusarium* spp., from " root rots " of lettuce and runner bean have been made. Such fungi, associated with " soil sickness " and unhealthy root systems, require specialised conditions for attack. Normal inoculation work has been inconclusive and chambers in which plants may be grown under controlled conditions are in course of construction. The number of bacterial leaf rots of lettuce which have been received from growers, has called attention to the commercial importance of this group of diseases. A collection of the organisms is being made.

Fungi isolated from rhubarb have been tested for pathogenicity but the results were disappointing. Parallel inoculations with bacteria are in progress.

Work on the wilt diseases of the carnation has been resumed. As suggested in the 1928 report, *Fusarium* spp. other than those named have proved pathogenic. A species of *Verticillium* has been found to be the main cause of wilt upon a badly affected nursery. The conditions leading to the wholesale destruction of carnation beds and the possibility of transmitting the diseases in cuttings from nursery to nursery are receiving attention.

Virus diseases.

During the year a comparison of English and Canadian virus diseases of tomato was completed. This investigation, carried out in collaboration with workers at the East Malling Research Station and Rothamsted Experimental Station, has shown that the commoner virus diseases of tomato are the same in both countries.

In connection with the above work the various tomato virus diseases of this country were critically examined and certain slight changes in nomenclature have been proposed.

The examination of mosaic diseases of the cucumber was continued. Three types of cucumber mosaic are now recognised and the nomenclature of this group of diseases has been revised.

The attention of growers is drawn to the fact that smoking tobacco frequently contains active viruses (of twenty-six samples of commercial tobacco tested during the year only two were virus-free) and is probably one source from which outbreaks of tomato mosaic originate.

A large number of chemical substances have been isolated from the soil of nurseries where virus diseases have caused serious injury over a number of years. Young tomato plants have been grown in solutions and suspensions of these substances in water and in soil to which the substances have been added, to ascertain if they are able to produce virus diseases in the plants. Some of these substances were injurious to plants when present in minute amounts in aqueous solution but in no case were symptoms of virus diseases observed in the plants.

Other investigations.

Additional work on the preparation of fungicides and combined fungicide-insecticide mixtures has been undertaken with special regard to the control of rust on roses and both leaf mould and the red-spider mite on tomatoes.

The work on light and temperature in relation to assimilation and translocation has been continued, but although interesting results have been obtained by studies on seedling plants much remains to be done before the methods can be applied to large plants at the stage of fruiting.

The conditions of water uptake and loss by tomato leaves are being investigated and the rules suggest that the usually accepted "percentage water content" of the whole leaf may fail to give a satisfactory index of the conditions obtained in the assimilating tissue.

The effect of rate of change in length of day on metabolism is under investigation and indications have been obtained that a close correlation may exist.

Analyses of chrysanthemum plants grown with various manurial treatments show that the interesting relation between phosphatic fertilisers and potash absorbed already reported for tomato foliage is not so pronounced in the case of chrysanthemums. The plants were grown in soils which had received the same treatment for some years and the treatment, omitting dung, was continued during the life of the plants. The ash, potash and phosphoric acid contents were highest in those chrysanthemums grown in soil which received complete artificials plus dung, and were lowest in those which were unmanured or which had received complete artificials without potash. The omission of phosphates, nitrogen or potash respectively lowered the ash and potash contents of the plants. Omission of phosphates or of potash but not of nitrogen lowered the phosphoric acid contents. Preliminary analyses of the " normal " and " blotchy " pulp from blotchy tomato fruit indicate that the " normal " pulp contains rather more potash.

Several cases of damage to tomato plants of various ages have been traced to the use of chlorate weed killers. Attention is drawn to the necessity of exercising the greatest care in the use of these compounds anywhere near houses, etc., where plants are to be grown.

Titles of papers issued during the year.

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2. ———: Tomatoes: Cultivation, diseases and pests. *Bull.* 77, *Min. Agric.*, 1934.
3. ———: Health and disease in plants. *J. Roy. Hort. Soc.*, **59**, 4, 386-396, 1934.
4. Bewley, W. F., and Secrett, F. A.: Cultivation of lettuce for market. *Roy. Hort. Soc.*, 1933.
5. Bewley, W. F., and Harnett, J.: The cultivation of mushrooms. Shepherd and Hosking, Ltd., London, 1934.
6. Speyer, E. R.: Some common species of the genus Thrips (*Thysanoptera*). *Ann. Appl. Biol.*, **21**, 1, 120-152, 1934.

17. JOHN INNES HORTICULTURAL INSTITUTION, MERTON, LONDON

The work of the John Innes Horticultural Institution is primarily concerned with the study of the genetics and cytology of plants from the standpoint of pure science, the results derived therefrom provide a theoretical basis for the work of the economic plant breeder. Incidentally varieties of commercial value arise from time to time, both among ornamental plants and fruit, and it is the practice of the Institution to pass these on to commercial firms interested.

Of most economic interest are the investigations dealing with apples, pears, plums, cherries and various species of Rubi. With apples the investigations are chiefly concerned with varietal sterility and cross-fertilisation, with the inheritance of characters like colour, size, flavour, etc., and with the production of stocks immune to woolly aphis. Collaboration with East Malling Research Station, where the value of the seedlings for immunity and as stocks is tested, has resulted in the selection of two stocks for wider testing in this and other countries. Certain seedlings of promise as dessert varieties are now being grown on a larger scale at two centres in Surrey in order to ascertain their commercial value.

With pears, studies in cross-pollination are going on, and the discovery of many triploids among pears shows there is need for more exact knowledge.

The pollination experiments among plums show that many of the finest varieties are self-sterile and fall into groups that are self-sterile *inter se.* A number of seedlings of commercial promise are under test on a larger scale at other centres. The sweet cherries are all self-sterile and again fall into groups that are sterile *inter se.* These trials have now been going on for a number of years and have included nearly all of the varieties that are grown in this country. Some seedlings of promise have been sent to the Kent Farm Institute at Borden for test against the commercial varieties. Among Rubi, the inheritance of characters in the raspberry is being extensively studied, as also of the complex polyploids that exist among the raspberry-blackberry hybrids. A race of spineless blackberries has been evolved and though none of the seedlings have as yet shown satisfactory fruitfulness, many hundreds of a later generation are now being grown on for trial. One variety raised at the Institution, though spiny, has now been put on the market because of its vigour, fruitfulness and the quality of its fruit.

The chief plants under study from the genetic side include the Chinese primrose, the auricula and other primulas, the garden pea, the sweet pea, wallflower, maize, *Nicotiana*, *Tropaeolum* and the tomato. The Chinese primrose has been the subject now of many years' investigation on the interaction of the genes and as new mutations arise from time to time fresh light is thrown upon the constitution of the chromosome outfit of this species. The work on the garden pea may throw light on the occurrence of rogues which occur in the purest strains of commercial varieties. The work upon maize bears incidentally upon the production of varieties both of " sweet corn " and feeding maize which will ripen in this country. With tomatoes the investigations are chiefly concerned with inheritance in tetraploids, which can be produced artificially, but which however are unlikely to have any economic value.

Titles of papers issued during the year.

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2. Buxton, B. H., and Dark, S. O. S.: Hybrids of *Digitalis dubia* and *D. mertonensis* with various other species. *Ibid.*, **29**, 109-122, 1934.
3. Crane, M. B., and Lawrence, W. J. C.: Genetical studies in cultivated apples. *Ibid.*, **28**, 265-296, 1933.
4. Dark, S. O. S.: Chromosome studies in *Scilleae*. II. *Ibid.*, **29**, 85-98, 1934.

5. Darlington, C. D.: Chromosome study and the genetic analysis of species. *Ann. Bot.*, **47**, 811-814, 1933.

6. ———: Studies in *Prunus*. IV. *J. Genet.*, **28**, 327-328, 1933.

7. ———: The origin and behaviour of chiasmata. IX. Diploid and tetraploid *Avena*. *Cytologia*, **5**, 128-134, 1933.

8. ———: Anomalous chromosome pairing in the male *Drosophila pseudo-obscura*. *Genetics*, **19**, 95-118, 1934.

9. ———: The origin and behaviour of chiasmata. VII. *Zea mays*. *Z.I.A.V.*, **67**, 96-114, 1934.

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14. ———: Science and politics. *Nature*, **133**, 65, 1934.

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16. ———: A contribution to the theory of price fluctuation. *Rev. Econ. Stud.*, **1**, 186-195, 1934.

17. ———: Inheritance of habits. *Nature*, **134**, 28, 1934.

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19. Hughes, A. W. McKenny: Aphides as vectors of "breaking" in tulips. *Ann. Appl. Biol.*, **21**, 112-119, 1934.

20. Koller, P. Ch., and Darlington, C. D.: The genetical and mechanical properties of the sex-chromosomes. I. *Rattus norvegicus* ♂. *J. Genet.*, **29**, 159-173, 1934.

21. Mather, K.: Interlocking as a demonstration of the occurrence of genetical crossing-over during chiasma formation. *Amer. Nat.*, **67**, 476-479, 1933.

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23. Pellew, C.: Hybrids in *Primula*. *Gard. Chron.*, **95**, 94-95, 1934.

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27. ———: Note on the cytology of *Saxifraga granulata* L., *S. rosacea* Moench, and their hybrids. *J. Genet*, **29**, 197-201, 1934.

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31. Sansome, F. W., and Zilva, S. S.: Polyploidy and vitamin C. *Biochem. J.*, **27**, 1935-1941, 1934.

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33. Schafer, B., and La Cour, L.: A chromosome survey of *Aconitum*. *I. Ann. Bot.*, **48**, 693-713, 1934.

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D

ENTOMOLOGY AND PLANT PATHOLOGY

18. PLANT PATHOLOGICAL LABORATORY, MINISTRY OF AGRICULTURE AND FISHERIES

As in previous years, many specimens of imported plants and plant produce have been examined in connexion with the possible introduction of plant pests and diseases. The situation in respect of the Cherry Fruit Fly and the Potato Moth remains as described last year ; various other imported insects have been under investigation and an outbreak of the Fluted Scale appears to have been suppressed. The occurrence of the Colorado Beetle near Tilbury again involved much detailed inspection work and investigation of protective and control measures. The operations up to the present appear to have been successful.

The increasing importance to the farming industry of the damage caused to potato and other crops by eelworm pests has resulted in much attention being given to this subject, and involved the examination of large numbers of samples.

Work in connexion with measures for the testing and standardisation of insecticides and fungicides has continued, and, in collaboration with the manufacturers, a Bulletin has been issued containing agreed specifications and methods of analysis for a number of commonly used products (9). Experiments on the cultivation of pyrethrum for insecticidal purposes have also been continued.

The supposed " degeneration " of certain stocks of Golden Spur daffodils has continued to receive attention, whilst trials with tulips, the outermost fleshy bulb scale of which was badly discoloured and showed mouldy lesions, demonstrated that these disfigurements did not prevent the plants from growing and flowering to full perfection. The experiments on " Hard Base " of tulips, referred to on pp. 106-108 of the Bulletin mentioned below, were continued. In a pot experiment, devised to ascertain what effect, if any, waterlogging of the soil might have on the production of pea seeds affected with Marsh Spot, the results were negative, since not a single seed affected with the trouble was produced. Seedlings, raised under protected conditions, from twelve samples of antirrhinum seeds collected from plants affected with Rust did not contract the disease, thus bearing out previous experience that this Rust is not a seed-transmitted disease.

Titles of papers issued during the year.

1. Fryer, J. C. F.: The Colorado Beetle at Tilbury. *J. Min. Agric.*, **40,** 907-912, 1934.
2. ————: The Colorado Beetle, *Gard. Chron.*, **95,** 424, 1934.
3. Gimingham, C. T.: Recent researches on insecticides in Great Britain. *Proc. Fifth Pacific Sci. Congr.*, **5,** 3423-3437, 1933.
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6 Pethybridge, G. H.: Snapdragon Rust. *J. Min. Agric.*, **41,** 336-340, 1934.
7. ————: Antirrhinum Rust and Asparagus Rust in England. *Trans Brit. Myc. Soc.*, **18,** 349-350, 1934.
8. ————: Potato Diseases. Problems of potato growing. *Roth. Conf.*, **16,** 9-17, 1934. Reprinted *J. Min. Agric.*, **41,** 125-136, 1934.
9. Specifications and methods of analysis for certain insecticides and fungicides. *Bull.* 82, *Min. Agric.*, 1934.

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19. POTATO VIRUS RESEARCH STATION, CAMBRIDGE UNIVERSITY

The investigations into the occurrence of biotypes of the "X" virus and the phenomenon of protective vaccination, reported on last year, have been continued.

The mutation of one form of the virus to another has been demonstrated. Passage of the "S" or severe form of the "X" virus through sugar beet and some other plants, in all of which the virus fails to become systemic, will frequently effect a mutation of "S" to "G", the mild form. The reverse mutation, though suspected, has not been conclusively demonstrated. Mutations from the "S" to the "L" form have also been demonstrated as an effect of virus purification.

The production of anti-sera has been continued.

A scheme for the improvement of potato seed of Great Britain is under consideration. The essence of the scheme is basic virus-free stocks and their multiplication under controlled conditions and a continuous cyclic rotation.

Work has been continued on the "streak" diseases of the potato. A new necrotic disease, *Foliar necrosis*, has been described, and the reactions and properties of the causative virus, provisionally named potato virus "D", studied. The virus is similar to, but not identical with, potato virus "X". Following the work on protective inoculation with different strains of virus "X", it has been found that plants infected with virus "D" acquire a resistance to further infection with virus "X", and *vice versa*. The disease induced in potatoes by virus "D" varies considerably in different varieties, and its reactions on 28 commercial varieties has been ascertained.

Evidence has been obtained that Up-to-Date and certain other "streak" carriers are infected with at least two viruses, only one of which is needle inoculable to potatoes. Attempts to separate and isolate these viruses are in progress.

A new virus disease occurring spontaneously on various solanaceous plants has been discovered which presents some unusual characteristics.

The measurement of the particle-size of plant viruses by the Elford ultra-filtration technique has been continued and it is hoped to evolve a method of classification of sap-inoculable potato viruses.

Work on the testing of virus-free potato stocks has been continued.

The work on the raising of *Phytophthora* resistant seedlings has progressed satisfactorily. Several highly resistant seedlings of good economic quality are now in hand. Very large numbers of plants have been tested and in the families now being bred for resistance, the ratio of seedlings resistant in their seedling stage is about 50 per cent. Selection of blight resistant and heterozygous parents which display resistance or tolerance to virus infection in the field has been steadily pursued. We have therefore now acquired a number of new seedlings combining blight resistance and tolerance to virus infection; many of these seedlings are also resistant to wart disease.

Crosses between distinct species of potato have been made and have resulted in the production of a group of blight resistant seedlings which produce good tubers in the winter months.

It has been found necessary to study the nature of the infection of potatoes by *Alternaria solani*, as this disease has not only occurred in the field plots, but also in the glasshouses during the last two years.

Entomology.

Considerable evidence has now been accumulated to show that the vector of the potato virus "X" is a species of thrips. Laboratory and field trials with this insect on a fairly extensive scale are being continued.

Titles of papers issued during the year.

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2. ———: Research in relation to the production of "good" potato seed. *Agric. Prog.*, **11**, 77, 1934.
3. ———: Virus disease research in relation to the cultivation of the potato. *H.E.A. Yr. Bk.*, 2, 45, 1933.
4. Smith, K. M.: Insects in relation to virus diseases of plants. *Agric. Prog.*, **11**, 86, 1934.
5. ———: The plant virus in the insect vector. *Arch. Zellforsch.*, 15, 1934.
6. ———: Some aspects of the plant virus problem. *Agric. Prog.*, **11**, 88, 1934.
7. ———: The mosaic disease of sugar beet and related plants. *J. Min. Agric.*, **41**, 269, 1934.

20. PLANT PATHOLOGICAL LABORATORY, DEPARTMENT OF AGRICULTURE FOR SCOTLAND

The Plant Pathological Laboratory of the Department of Agriculture for Scotland is the central clearing house for plant disease problems of the three Scottish Agricultural Colleges. Many problems involve a certain amount of *ad hoc* research; for example, a new *Phytophthora* attacking the small roots of tomatoes has caused much damage. Some 500 cases of disease were dealt with during the year.

Leek and potato diseases.—Research is being continued on various Leek diseases and especially on the White Tip (*Phytophthora*) disease; breeding and selection for immunity being two of the chief methods of research. Various control experiments on both Corky and Ordinary Scab of potatoes are in hand, being carried out at the Seed Testing Station and on their land.

Wart disease.—The mycological determinations of the wart disease tests were continued. Certain research on the life history of this fungus is also being carried out.

Strawberry disease research.—This investigation is being continued in co-operation with the John Innes Horticultural Institution. More attention is being paid to the question of breeding immune varieties of strawberries.

Seed-borne diseases.—Research on these was continued during 1934 and an interesting point arose, i.e., the fungus *Polythrincium trifolii* (causing a leaf disease of English wild white clover) was proved to be seed-borne.

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21. (SEED TESTING AND) PLANT DISEASES DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

Plant Pathology.

Cereal Diseases.

Disinfection of " seed " oats.—The use of organic mercury dusts for the disinfection of " seed " oats is still growing in routine farm practice. During the year considerable attention has been given to the evaluation of these compounds in securing the control of leaf stripe (*Helminthosporium Avenæ* Eidam.). A comprehensive series of pot experiments carried out over the spring and summer periods has provided information whereby it is hoped that a rapid test for disinfectants designed to measure their efficiency in controlling this disease will be evolved. A large number of disinfectants were tested in the field and their relative values assessed.

Another series of large-scale field experiments have been carried out in collaboration with the County Agricultural Instructors.

Results obtained by such experiments, which have now been carried out over a period of four years, show that seed disinfection may be safely recommended in general farm routine. The small-scale field experiments were carried out at the Agricultural Research Institute, Hillsborough.

Potato Diseases.

Ordinary or late blight (*Phytophthora infestans* (Mont.) de Bary).—A comprehensive series of spraying trials to compare the value of various proprietary fungicides with that of Burgundy mixture was again carried out. This series of trials has become an annual feature of the work and apart from assessing the relative values of the various materials used it has been possible through the results obtained to provide the manufacturers of proprietary fungicides with useful information. Although up to the present no proprietary fungicide tested has given as good results as Burgundy mixture, yet a definite rise in the efficiency of proprietary materials considered as a whole has been noted during the course of the work.

The study of varietal susceptibility to blight of haulms and tubers of various potato varieties has been continued.

Disinfection of " seed " tubers.—This work was undertaken with the view of investigating the value of various disinfectants for controlling skin-borne diseases of the potato tuber. The promising results obtained in 1933 in connection with the control of common scab (*Actinomyces scabies* (Thaxt.) Güss.) led to the amplification of this work. From the results of a large number of experiments carried out in 1934, it is clear that in many cases a very satisfactory control of this disease may be obtained by disinfecting affected " seed " tubers before planting. The use of an " instantaneous " dip has been found to be as satisfactory as the steep method. By the employment of an " instantaneous " dip the process is made more practicable inasmuch as the necessity for steeping the tubers for a lengthy period has been overcome. Owing to the non-occurrence of powdery scab (*Spongospora subterranea* (Wallr.) Lagerh.) during the season no results were obtained for this disease.

Fruit Diseases.

Apple scab (*Venturia inæqualis* Aderh.).—Except for comparative tests designed to compare the efficiency of Bordeaux mixture, commonly used to control apple scab in Northern Ireland, with lime sulphur, dusting sulphur and various proprietary spray fluids, no further work was carried out with this disease during the year. Up to the present no spray fluid has been found which can be recommended to take the place of Bordeaux mixture.

Better fruit yields were obtained from the apple tree manurial experiments being carried out in collaboration with the County

Horticultural Instructors. Fruit from these centres was again despatched to the Department of Botany, Imperial College of Science and Technology, where interesting results have been obtained with regard to the composition of the fruit and its susceptibility to attack by apple rotting fungi.

Gooseberry rust (*Puccinia Pringsheimiana* Kleb.).—Amplified experiments have been carried out in connection with the control of this disease and the results obtained during previous seasons have been fully confirmed. Successful control of this disease may be obtained by spraying the bushes with a weak copper fungicide in early spring.

Vegetable Diseases.

Finger and toe of Brassicae (*Plasmodiophora Brassicae* Woron).—Further work carried out in connection with the use of mercuric chloride for securing the control of this disease has again given results in its favour. This method is becoming widely used throughout the country and so promising have the results been that vegetable growers who farm on a fairly extensive scale have adopted it as a routine measure. In many cases it is being used where finger-and-toe is not severe, but even so, the results obtained seem to have fully justified its use.

Diseases of ornamental plants.

Rose rust.—The summer spraying trials were continued in 1934 on the same lines as in previous years. Two extra sprays were used, viz., oil-Bordeaux and a mixture of colloidal copper and colloidal sulphur. These gave the best results in the order named. Used alone, the colloidal copper was unsatisfactory as it caused much defoliation. On another nursery, colloidal copper and Bordeaux mixture both caused severe defoliation, whereas oil-Bordeaux had very little harmful effect.

Carnation wilt.—Regular observations over the whole cropping period are being made in a carnation house part of the soil of which was steam-sterilised. Some deaths have occurred in both the sterilised and the unsterilised portions of the house. A comparison will be made on a percentage basis.

MYCOLOGY.

The second annotated list of additions to the fungus flora of Ulster has been published during the year (1).

ECONOMIC ENTOMOLOGY.

Apple tree pests.

Capsid bugs (*Plesiocoris rugicollis*, *Lygus pabulinus*).—As a result of experiments carried out at various centres in County Armagh it has been established that very satisfactory control of capsid bugs can be obtained by the use of certain petroleum oil sprays. Arising out of these investigations, it is clear that correct timing of spraying operations is of vital importance. Spraying should be carried out immediately after the buds have burst and, to avoid spray damage, should be completed before the leaves have commenced to separate. Combination sprays containing both petroleum oil and tar distillate, which were applied while the buds were still dormant, also gave good results. Almost complete control of the pests was obtained by a " delayed-dormant " spray with petroleum oil emulsion followed by three applications of nicotine in summer.

Red spider (*Oligonychus ulmi*).—Field trials against this pest were carried out at two centres and the figures obtained showed that petroleum oil emulsions applied in the " green-bud " stage and lime sulphur, colloidal sulphur, and dusting sulphur applied later all exercised some measure of control. In some instances, however, there was considerable foliage injury subsequent to the summer applications of the various forms of sulphur.

Blackcurrant pests.

Big bud mite (*Eriophyes ribis*).—The investigations relating to the control of this pest have been extended to embrace the effects of systematic spraying on the incidence of " reversion " which is spread by the mite.

Pests of root crops.

Carrot fly (*Psila rosæ*).—Further experiments have been carried out on the control of this pest and the findings of the two previous years have been confirmed. Naphthalene used in eight applications, again effected the most satisfactory control. Of the other deterrents used, a proprietary mixture of ortho- and para- dichlorobenzene used in four applications at intervals of fourteen days, gave the most promising results.

Turnip flea beetles (*Phyllotreta* spp.).—Work is in progress to determine whether these insects can be controlled by seed-treatment or by the application of deterrent dusts to the drills of turnips and swedes immediately prior to or after sowing. So far, the measures tried, although having no adverse effect on germination, have failed to control the pests.

Cereal pests.

Frit fly (*Oscinella frit*).—The results obtained from experimental plots during 1933 and 1934 demonstrate clearly the importance of this insect in the Province in relation to the oat crop. The recorded injury to both the braird and flowering stage was markedly higher in plots where the sowing date was delayed, and there was a corresponding reduction in yield. Plots sown on 12th May yield little more than half the total produce from similar plots sown on 8th April, and this decrease can be attributed largely to a higher degree of frit fly infestation.

Title of paper issued during the year.

1. Muskett, A. E., Cairns, H., and Carrothers, E. M.: Further contributions to the fungus flora of Ulster. *Proc. Roy. Irish Acad.*, **42**, B, 4, 1934.

AGRICULTURAL PARASITOLOGY

22. INSTITUTE OF AGRICULTURAL PARASITOLOGY, LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE

Infestation of farm stock, poultry and game.—For a third year in succession the effect of "rotational grazing" on the worm burden of sheep has been studied. Last year sheep were used on the experimental area but these have now been replaced by goats. From the results obtained it would appear that the summer months are more suitable for the development of *Haemonchus contortus*, while the species *Chabertia ovina*, *Trichostrongylus axei*, *Ostertagia circumcincta* and *O. trifurcata* are not inhibited during the cold weather and are picked up in considerable numbers during the winter months. Observations show that goats do not acquire any marked resistance with age to helminth invasion. Worm-free goats, three years old, were placed on infective plots and picked up considerable numbers of the chief intestinal parasites of pathological importance within a short time (9).

Field observations have been continued on the longevity of eggs and larvae of the different helminth species under varying climatic conditions.

Advantage was taken of the prolonged drought during the summer to study the viability of helminth eggs on the pastures. Sheep droppings over five days old lost over 90 per cent. of the viable eggs of nematodes. This action was hastened by the tunnelling of dung-beetles which have a desiccating effect on faecal masses on the pastures.

The effect of the drought on liver-fluke of sheep has also been studied. The eggs are quickly destroyed by drying and the range of the molluscan intermediate host, *Limnaea truncatula*, is markedly restricted. These new observations are of such great economic importance that public attention was drawn in the summer to the need of a change in the present desultory method of controlling fluke disease. It was recommended that instead of delaying the treatment of infected flocks and pastures until the autumn, or until the disease was rife, advantage should be taken of the drought periods to make a mass attack on the fluke and its carrier. It may be remarked, however, that such a campaign could only prove successful if carried out by the farmers in the infected areas, on a large scale and at the same time, and it is suggested that nothing less than the organisation of a "Fluke

Week '', on lines similar to the '' Rat Week '', would secure effective application of these principles of control.

A notable observation was made on the appearance of a Trichostrongyle infection in worm-free sheep some weeks after these had been put on to a pasture which had not previously carried any stock. It was successfully demonstrated that this infection was derived from wild rabbits and has thus revealed an unexpected reservoir of infection which will render the breeding of a worm-free stock extraordinarily difficult.

During the past year the following investigations were continued :—

(*a*) The influence of nutrition on susceptibility to helminth parasites (1, 2, 3).

(*b*) The life-history of the gapeworm, with special reference to the role of wild birds in its spread to poultry, partridges and pheasants (4).

The treatment of gapeworms has been put on a scientific and effective foundation.

Work has been continued on plant parasitic nematodes on the field plots and, on a smaller scale, in a bird-proof wire enclosure which can be used as a nursery for diseased material (5).

Parasites of plants.—The field plot devoted to *Anguillulina dipsaci* on potato tubers has again been arranged to test the susceptibility of other agricultural crops to the potato strain of the parasite. The dry seasons of 1933 and 1934, coupled with the lifting and removal of the potato crop each season, has resulted in the plot now carrying a very light infection.

On the plot carrying the '' oat '' strain of *Anguillulina dipsaci* which gives rise to '' tulip root '' in oats, a considerable increase of the disease was effected by the laying down of dried infective oat material in the autumn of 1933 followed by autumn sowing. The weather during the winter favoured the disease with the result that the seedlings were severely attacked. The infectivity of the oat strain of *A. dipsaci* to various other crops and on a '' giant '' race of the same parasite attacking broad beans has been investigated.

Anguillulina tritici, the cause of '' cockle '' in wheat, having been nursed in the wire enclosure, has again been established on a field plot and this year has resulted in a good infestation. This is providing material for special studies on the pathology of gall formation.

Papers have been published on an eelworm disease of cultivated violets (7); on certain semi-parasitic nematodes occurring round grass roots and on the pathology of gall formation on a fescue grass attacked by *Anguillulina graminis* (6).

The investigations on the eelworms of the genus *Heterodera* have been continued (10, 11).

Field experiments in Yorkshire on a biological method of controlling *Heterodera schachtii*, the root eelworm of potatoes, have been maintained throughout the present season and a similar experiment is being carried out in Bedfordshire. Control by means of chemical applications to soil is being investigated in laboratory studies and in a field trial in Bedfordshire.

The reactions of the root-knot eelworm, *Heterodera marioni*, to methods found to give some control of *Heterodera schachtii* are being tested in the glass-house at Winches Farm, where tomatoes and tobacco are the host plants in use.

Further infective material of Red-ring Disease in coconuts having been sent from Trinidad, attempts are being made to produce infections of date palms for a study of this disease. Infected material of *Aphelenchoides ribes*, the black-currant nematode, was received in the spring of 1934 and transmission experiments have been carried out.

Parasites of insect pests.—The investigations on the helminth parasites of insects and the collection and dissection of *Phyllotreta* beetles in order to determine the percentage of parasitism obtaining in the five species of flea beetles concerned have been continued. Results differ from those of 1931 and 1932, but these differences may be associated with weather conditions.

Titles of papers issued during the year.

1. Clapham, P. A.: Some observations on the response of chickens to infestation with *Heterakis gallinae*. *J. Helminth.*, **12**, 71-78, 1934.
2. ———: Some observations on the effect of dietary deficiency on infestation of chickens with the nematode *Heterakis gallinae*. *Ibid.*, **12**, 123-126, 1934.
3. ———: Ascariasis and vitamin A deficiency in pigs. *Ibid.*, **12**, 165-176, 1934.
4. ———: Experimental studies on the transmission of gapeworm (*Syngamus trachea*) by earthworms. *Proc. Roy. Soc.* Series B, 791, 18-29, 1934.
5. Goodey, T.: Observations on *Paratylenchus macrophallus* (de Man, 1880). *J. Helminth.*, **12**, 79-88, 1934.
6. ———: On gall-formation due to the nematode *Anguillulina graminis*. *Ibid.*, **12**, 119-122, 1934.
7. Goodey, T., and Staniland, L. N.: A dwarfing disease of cultivated violets associated with the eelworm, *Aphelenchoides olesistus*. *Ibid.*, **12**, 13-22, 1934.
8. Morgan, D. O., and Clapham, P. A.: Some observations on gapeworm in poultry and game birds. *Ibid.*, **12**, 63-70, 1934.
9. Oldham, J. N., and Morgan, D. O.: Helminth parasites observed in a herd of goats maintained at St. Albans, England. *Ibid.*, **12**, 39-46, 1934.
10. Anon. (Triffitt, M. J.): Memorandum on eelworm (*Heterodera schachtii*) and potato sickness. *Agric. Inst., Kirton, Boston, Lincs*, 1933.
11. Triffitt, M. J.: Experiments with the root excretions of grasses as a possible means of eliminating *Heterodera schachtii* from infected soil. *J. Helminth.*, **12**, 1-12, 1934.

23. DIVISION OF HELMINTHOLOGY, DEPARTMENT OF ZOOLOGY, UNIVERSITY OF EDINBURGH

Parasites of poultry.—The principal research activity during the year has been the study of intestinal worms of poultry in Scotland. Advantage has been taken of the large number of birds sent to the Royal (Dick) Veterinary College for diagnoses to examine them carefully for parasitic worms. The species present as well as the intensity of the infection have been recorded and the data thus obtained should form a useful survey of the helminths of poultry in Scotland.

About 520 birds were examined during the period and the survey showed that *Heterakis gallinae* and the various species of the genus *Capillaria* were by far the most common worms present. *Ascaridia galli* was far less common and the only tapeworm of importance was *Davainea proglottina.* Particular attention has been paid to birds suffering from fowl paralysis since the presence of worms is considered to be a predisposing cause of this disease. During the survey some of the heaviest infestations were certainly found in such birds but it is considered that a lowered resistance resulting from fowl paralysis might equally well account for the abnormally heavy helminth infestations encountered. It has been decided to continue this survey for another year so that further data can be obtained on such questions as seasonal incidence and the relation of worms to other diseases.

The Poultry Department of the East of Scotland College of Agriculture, owing to its proximity to the Department of Zoology, is affording a valuable observational area for the study of poultry parasites under natural conditions. An experiment has been initiated to test the value of various chemicals, especially on pens heavily contaminated with worm eggs, and the observations will be continued during the spring and summer of 1935.

Parasites of sheep and pigs.—Valuable contacts have been made with agricultural organisers and sheep farmers in the Border areas and with pig breeders in the Edinburgh district. The information thus obtained has proved exceedingly helpful in outlining the major helminthic problems in those areas and the few examinations of stock that have been made have indicated the lines along which further work may usefully proceed.

Miscellaneous.—A number of examinations of faecal samples have been made at the request of veterinary surgeons and others and advice has been given on the control of worms in stock, particularly on redworms in horses and " husk " in cattle. A few animals which died in the Zoological Park have been examined for helminths.

Titles of papers issued during the year.

1. Oldham, J. N., and Morgan, D. O.: Helminth parasites observed in a herd of goats maintained at St. Albans, England. *J. Helminth.*, **12**, 39-46, 1934.
2. Morgan, D. O., and Clapham, Phyllis A.: Some observations on gapeworm in poultry and game birds. *Ibid.*, **12**, 63-70, 1934.

ANIMAL PATHOLOGY

24. RESEARCH INSTITUTE IN ANIMAL PATHOLOGY, ROYAL VETERINARY COLLEGE

MASTITIS IN BOVINE ANIMALS.

Diagnosis.—An investigation was made of the accuracy of " indirect " methods of diagnosis of chronic (contagious) streptococcal mastitis, as compared with the accurate but lengthy " direct " method of seeding milk on to a selective culture medium (1). Only cows in full lactation were considered, as indirect tests are known to be unreliable on cows near the dry stage. The indirect tests applied to the milk were (*a*) inspection of a thin layer for floccules, (*b*) estimation of the reaction to brom cresol purple, and (*c*) noting the amount and character of the material deposited by centrifuging a fixed volume of it. Of 528 infected quarters, 62 per cent. showed abnormalities by at least one of the indirect tests : but 9·4 per cent. of the samples from 2,284 healthy quarters were abnormal by the same criterion. The latter result is probably due partly to the inclusion of some cows that were not really in full milk, and partly to mild and non-important' infections of the udder by other organisms. If on the other hand a positive result in all three tests is taken by the criterion, the percentage of quarters in which latent streptococcal infection can be detected falls to 40 per cent (2).

Control.—Observations relating to the control of streptococcus mastitis, which were started in 1929 on seven herds comprising 550 cows, are still in progress.

Treatment.—Tests have been carried out with a German proprietary acridine compound. A weak solution of this is infused into the udder after milking out, and withdrawn after five minutes : in a dry cow the solution is left in for 24 hours. Nine experimentally infected quarters were all cured, but in naturally infected quarters only 28 out of 50 dry quarters, and 29 out of 52 quarters in milk, were cured. Considering also results reported from Germany, it appears that the treatment is valuable in slightly infected cows, but not in severe or advanced cases. Milk secretion is interfered with for a short while only.

Staphylococcal mastitis.—A severe gangrenous mastitis is occasionally found, associated with a haemolytic staphylococcus. Investigation shows that this staphylococcus frequently occurs in the udder without producing any disturbance. The characteristics of these and allied staphylococci and the toxins produced by them are now being studied. It appears that certain toxins produced by haemolytic staphylococci from a number of animal species are all of a similar nature.

CONTAGIOUS ABORTION.

Incidence.—Further information relating to cattle and horses has now been collected and the final results have been published (3). Sera from cattle—1,210 in number—were taken at an abattoir which receives cattle from many parts of the country. 844 of these were collected by a butcher who slaughters any consignment sent and the sex of these animals was not noted; the remaining 366 were of uniformly higher quality and comprised 100 cows, 53 heifers and 213 steers. In the first batch of 844 animals, 27·5 per cent. were positive and 9·1 per cent. were intermediate or borderline; of the animals in the second batch the positive percentages for cows, heifers and steers were 14, 3·8 and 0·9 respectively, and the percentages of intermediate reactions were 7·0, 3·8 and 2·4. Thus, probably not less than 20 per cent. of the cows in this country are infected with *Br. abortus*, but owing to the extensive use of vaccines, and particularly of live vaccines, it is not possible to be sure how much of this is due to natural infection.

An experimental eradication scheme.—This scheme is designed to test the possibilities of controlling the disease under practical conditions, and, as the contribution of this Institute, preventive measures are now being carried out in 7 herds comprising some 420 animals. Supporting evidence is being sought in 13 other herds. A report setting out the position of the work in September, 1934, was presented to the Agricultural Research Council's Committee on Abortion. The progress is satisfactory, since among cows in the 7 herds the reactor rate has been reduced from 38 to 4·4 per cent. In 5 of the herds no reactors were found at the last routine test.

The bacterial suspension for agglutination testing at all centres under this scheme is being prepared at this Institute. For this much preliminary detailed work was carried out, in selecting suitable strains of *Br. abortus* and on methods of standardising the suspension.

Susceptibility of guinea-pigs, rabbits and mice to Br. abortus.—As a preliminary to work on the production of a dead vaccine for contagious abortion, it was decided to test the susceptibility of these animals. So far, the results indicate that the guinea-pig is the most suitable animal.

Incidence of tubercle bacilli and of Br. abortus in milk.—This work was undertaken with a two-fold object, firstly, as a direct enquiry into the presence of these organisms in different classes of milk, and, secondly, as a means of studying the distribution of "open" cases of these diseases in different kinds of herds and in herds situated (*a*) in a district densely populated with cattle and (*b*) in a more lightly populated area. Full results have been published (4).

Out of 101 samples of milk from 45 tuberculin-tested herds only one contained tubercle bacilli; on the other hand, 70 samples contained *Br. abortus*. Of milk samples from 105 non-tuberculin-tested herds in an area densely populated with cattle, 22 contained tubercle bacilli and 39 *Br. abortus*. Of 104 samples from similar herds in the more lightly populated area only 2 contained tubercle bacilli, while *Br. abortus* was present in 20. In the case of these 209 herds, the sample submitted was representative of every cow in the herd which was in milk at the time. The differences between the results in the two series are considered to be due to differences in herd size and also to reflect the conditions under which the cows are kept. The work also afforded an opportunity for studying the factors governing the isolation of *Br. abortus* from market milk.

JOHNE'S DISEASE.

The Institute has assisted in a second experiment on cattle designed to select the most suitable kind of Johnin for diagnosis.

Titles of papers issued during the year.

1. Edwards, S. J.: Studies on bovine mastitis. IX. A selective medium for the diagnosis of streptococcus mastitis. *J. Comp. Path. & Therap.*, **46**, 211-217, 1933.
2. ————: Studies on bovine mastitis. X. The value of field and laboratory tests for the diagnosis of chronic streptococcus mastitis. *Ibid.*, **47**, 49-60, 1934.
3. Priestley, F. W.: The incidence in Great Britain of *Br. abortus* infection in various domestic animals as indictaed by the agglutination test. *Ibid.*, **47**, 181-189, 1934.
4. Pullinger, E. J.: The incidence of tubercle bacilli and *Brucella Abortus* in milk. *Lancet*, 967-971, 5th May, 1934.

25. INSTITUTE OF ANIMAL PATHOLOGY, CAMBRIDGE UNIVERSITY

FILTERABLE VIRUSES.

Contagious pustular dermatitis of sheep and goats.—The results of vaccination experiments in the field covering several years have now been analysed. In older lambs the method appears safe: the incidence of disease among vaccinated animals is much less, and the attacks which do occur are less severe. Vaccination of younger lambs (2-3 weeks old) has been less satisfactory, as infection tends to spread to the lips from the inoculation site (thigh). Attempts to protect lambs by vaccinating ewes during pregnancy were unsuccessful.

Fowl Paralysis.—A survey of thirty-eight outbreaks of the disease has been made.

In view of the reports of other workers, haematological examinations have been carried out in order to ascertain whether there are any abnormalities in the number or proportion of the various corpuscular elements which may be regarded as characteristic of fowl paralysis (1). A slight increase in the total number of leucocytes was noted in some cases, but this did not appear to be consistent and moreover, there seemed to be no relationship between the leucocyte count and the severity of attack. In view of the fluctuation which may occur in the leucocyte counts of individual birds, it is not considered possible to diagnose fowl paralysis by blood examination.

Experiments on the attempted transmission of the disease have been continued. Seventy-six birds have been inoculated and are being subjected to detailed post mortem and histological examination with a number of uninoculated controls. During the past season the birds have been injected when very young and a certain proportion have been killed after the lapse of a short period and their tissues transferred to other batches of young chicks. It has been hoped that in this way it would be easier to establish the supposed infective agent of this disease. As in the previous series, the proportion of birds infected artificially has been remarkably low. A certain number of the birds killed six months or more after inoculation have shown definite lesions of fowl paralysis in the nerves, whereas the corresponding birds killed at an earlier date were free from infection. There is thus a suggestion of a long period of latency and the possibility that birds may become " carriers " of infection without showing clinical symptoms.

PATHOLOGY AND BACTERIOLOGY.

Contagious abortion of cattle.—The eradication of this disease by means of the agglutination test and the segregation of affected cattle, is being attempted on a number of farms, in collaboration with local practitioners.

A study of the channels of excretion of *Brucella abortus* by infected cattle and the period of its survival in excreted materials and in surface water, has been undertaken. The results at present available show that the organism may remain alive in the tissues of the aborted foetus for at least 113 days.

Diagnosis of entero-toxaemia in sheep.—The reliability of the methods commonly used in the examination of intestinal contents of sheep for the presence of *B. welchii* toxin has been investigated as it was deemed desirable to ascertain if any significant proportion of this toxin is likely to be removed in the various preliminary processes of filtration. Under the conditions which obtained in the experiments no appreciable loss could be detected as the result of passage through the Berkefeld candle or Seitz disc. In connection with type D toxin, however, certain points have arisen which demand further study.

Contagious abortion in sheep.—As the strains of bacteria obtained from two outbreaks of this disease were found to differ in several of their biochemical reactions from *Bact. abortus ovis* their antigenic structure has been examined in order to determine their relationship to that organism. In this respect only quite minor differences could be detected, these being concerned with a relative deficiency of group phase antigen.

Ovine strains of C. chauvaei.—Strains of *C. chauvaei* isolated from sheep have been examined in order to determine their serological type and particularly to ascertain whether they are identical with strains of bovine origin or belong to a different group.

Examination for the presence of Haemophilus in the pig.—The lungs and air passages of pigs dealt with in the diagnosis department of the Institute, have been examined for the presence of *Haemophilus* in order to obtain information as to the possible occurrence of that organism among swine in this country, with negative results.

BIOCHEMISTRY.

The effects of nematode infestation on the metabolism of the host.—Further experiments on the nezyme secreted by nematode worms have confirmed the results reported last year. This work has now been concluded.

Eclampsias of pregnancy in ewes.—During the Spring of 1934 blood samples from several cases of this type of disease were obtained from outbreaks occurring chiefly in Norfolk. The results of analysis were identical with those previously observed in the case of affected animals in Yorkshire and Northumberland.

Phosphorus deficiency with special reference to a defective condition of the bones of sheep found in certain areas of Northumberland and Yorkshire.—It was decided to explore the possibility of reproducing this condition by a diet moderately deficient in phosphate in the case of either normal sheep or those which are heavily infested with nematode worms. Metabolism experiments were therefore undertaken involving the systematic analysis of the animals' food and of their blood, faeces and urine. The results at present available have shown a definite increase in blood calcium from 11 mg. to 14 mg. per 100 c.c. while inorganic phosphorus has fallen from 4·5 mg. to 1·85 mg.

Lactation tetany.—As the result of the investigation carried out in 1933 which revealed a reduction in the magnesium content of the blood not only of affected cows, but also of "in-contact" animals kept under identical conditions, it was decided to make a periodic examination of the blood of a susceptible herd to ascertain when this reduction actually occurs. A sudden fall was noted in more than 50 per cent. of the herd within a few days of being turned out to grass, though only one animal showed symptoms of lactation tetany. This reduction was limited to the period during which cases of the disease are known to occur in the district concerned. A similar fall in blood magnesium was detected in cows moved in the spring from non-affected to affected farms, but in this case the number of animals involved was too small to allow of definite conclusions being drawn. In a control herd in a district where the disease is unknown no such variation in blood magnesium was observed.

The physiology of cellulose digestion.—Rabbits, whose liver glycogen reserves had been drastically reduced by injections of phloridzin, were fed a ration consisting of filter paper porridge, killed after 48 hours and the glycogen content of their livers estimated. The results tended to show that the animals were able to form glycogen from the cellulose of their diet. This was substantiated by blood and urine analysis of rabbits which were injected with phloridzin whilst being fed on a filter paper diet.

BIOLOGICAL PRODUCTS AND IMMUNITY.

Tuberculin.—The investigation into synthetic tuberculin has been continued with special attention to the keeping qualities of the product and the best method of preservation. Batches of the material maintained at a low temperature have retained their potency apparently unimpaired for two years.

Johnin.—The further study of synthetic johnin which was subjected to a preliminary investigation has not been continued owing to a lack of experimental johne-affected animals.

Vaccination of calves against tuberculosis with B.C.G. vaccine.—The experiments which were designed to test the possibility of reinforcing a waning immunity by re-vaccination have been completed. The administration of a single intravenous dose of 100 mg. of vaccine at intervals of six, nine and 12 months after the initial immunizing dose, followed by a test dose of virulent culture six months later, has given the following results. At six months three animals out of five were free from disease, while the remaining two were affected to a less extent than the controls. After a nine-month interval three were entirely free from tuberculosis and one had very slight lesions only, while after 12 months two animals showed no lesions, one a slight infection and one a fairly severe infection of the mesenteric glands. In all the affected cases the lesions were less in extent than in the controls, and tended to show fibrous encapsulation.

Allergy in tuberculosis and tuberculin testing.—During the course of the experiments on vaccination with B.C.G. the opportunity has occurred to study certain aspects of allergy in cattle. It has been found that after inoculation with B.C.G. a definite skin reaction to tuberculin may be obtained at about the seventh day, after which the response to tuberculin increases in magnitude up to from four to six months. It then declines gradually but may still be discernible two years later though it is usually lost after about 18 months. This is in conformity with the view that allergy is at its height during the course of the active process of the disease.

Experiments have also been undertaken on the fluctuation in sensitivity to tuberculin. On the one hand it has been found that in tuberculous animals in which the reaction to tuberculin is very extensive, an inoculation of glycerine broth near the site of the tuberculin injection may present pseudo-positive characteristics. Further, it has been shown that this type of sensitivity is purely a local reaction. Conversely another series of experiments has shown that the skin can be desensitized to some extent by an injection of tuberculin but that the diminution in the allergic reaction is confined to the immediate neighbourhood of the original site.

MORBID ANATOMY AND HISTOLOGY.

Routine post-mortem examination of dogs.—Over 60 dogs have been submitted to detailed post-mortem examination with subsequent minute anatomical and histological study. Work along these lines promises to yield much valuable information regarding the general and special diseases of this animal. Particular attention is being directed to nephritis, in continuation of work carried out in past years on the morbid anatomy, histology and classification of kidney diseases; incidence, nature and malignancy of neoplastic conditions; and nature and causes of nodular or diffuse enlargements of the spleen and lymphatic glands.

Fowl paralysis.—In an attempt to determine the nature and genesis of the cells which occur in the infiltrative lesions of the peripheral and central nervous system in fowl paralysis, affected birds have been subjected to intra-vitam staining as an aid to the histo-pathological study of the condition. This work is still proceeding.

PHYSIOLOGY.

Toxins of C. Welchii.—A study has been made of the physiological action of the toxins of the B, C and D types of *C. Welchii.* Their most pronounced effects appear to be due to a peripheral and not a central action. In each case after intravenous injection, there is a rapid rise of blood pressure and depression of the respiratory movements. There is ultimately a slowing of the heart rate, fall of blood pressure, respiratory failure and death. Using sub-lethal doses of B or C toxins, it was found that tissue desensitization could be produced. It is proposed to study this effect further. The actions of these various toxins on the heart itself resemble one another closely and from a physiological point of view the difference between them is one of degree and not of kind. Experiments with excised intestinal strips have not given uniform results and it is proposed to test the action of the toxins on the smooth muscle of the intestine by means of a different technique.

Bracken.—The action of various salts obtained from extracts of bracken has been tested by physiological methods. Although the majority of these substances possess toxic properties, it has been concluded from the nature of their action in the animal body that they probably play little or no part in bracken poisoning as it occurs in the field.

PARASITOLOGY.

Nematode larvae.—Work on the infective and first parasitic larvae of nematodes parasitic in sheep has been continued. Particular attention has been paid to the mechanism of the second ecdysis of infective larvae and the consideration of the physicochemical factors in the alimentary canal which may influence this process. Attempts have been made to cultivate the first parasitic larvae in sterile media resembling those encountered by these larvae in the body of the host; the effects of digestive juices on the infective larvae have also been studied.

Several methods of recovering the larvae of parasitic worms from turves have been tested. It was found possible to kill off the free-living forms by the addition of weak acid and thus obtain larvae, all of which appeared to be those of parasitic worms. A few preliminary experiments have also been made to test the effect of bleaching powder on parasitic larvae present on turves.

Blackhead in turkeys.—Further attempts have been made to cultivate the protozoan *Histomonas* in the absence of associated bacteria. Material from the liver lesions had to be used for this purpose as being the only source from which to obtain the parasite in a state of purity. Various types of media, including actively growing tissue cultures of hen-chick liver and caecum have been used, but up to the present it has not been possible to induce the organism to multiply.

Coccidiosis.—The work on the identification of the species of *Eimeria* affecting chickens has been continued as material has become available. In a number of cases *E. necatrix* was the chief factor in causing the disease and in others *E. tenella*. Many birds were found to be affected with *E. acervulina* either with or without *E. maxima*, whilst in a few cases the last named was present in the greatest numbers.

Onchocerca gutturosa.—The occurrence of this nematode parasite in cattle in this country has been recognised for the first time. Examination of worms from a series of cows in Cambridgeshire and Herefordshire suggests that *O. gutturosa* and *O. bovis* are one species and that this is closely allied with *O. Gibsoni*, the cause of " worm nests " in cattle in Australia. As a result of the dissection of large numbers of blood sucking flies of various genera, it has been found that the vector of the parasite is *Simulium ornatum*. By rearing *Culicoides nubeculosus* in the laboratory and feeding it on an infected cow, it has been determined that this fly, which is the vector of *O. cervicalis*, is not concerned in the transmission of *O. gutturosa*.

Several species of midges (*Culicoides*) and Black Gnats (*Simulium*) which had not previously been recorded as feeding on domestic animals, were caught on horses and cattle and some new observations made on the biology of midges which are important pests of man as well as of animals. Apparent local variants of two species of *Simulium* were obtained in Herefordshire during this work.

Fistulous withers and poll evil.—Examination of material from 19 cases has shown that in 13 (68 per cent.) the affected horses were harbouring living *Onchocerca cervicalis*. Agglutinins to *Br. abortus* at a titre of 1 in 80 or upwards were present in the sera of 11 of 16 cases examined (68·75 per cent.). The remaining five gave no agglutination; *Onchocerca* was present in four of these.

PLANT POISONS.

Bracken.—Preliminary feeding experiments have shown that bracken is toxic to guinea pigs and rabbits. The average fatal dose for these animals of both the fresh and dried plant, has been determined. The symptoms and post-mortem findings agree with those described for cattle, except that in none of the experimental animals was a rise of temperature observed. Histological examination suggests that the liver is the organ which suffers the most damage after the ingestion of bracken and in some cases fatty degeneration of the liver cells may be marked. The results suggest that there is a degree of individual susceptibility to the plant, and that an animal may become tolerant to its action.

The variations in its chemical composition from month to month are being studied. Alcoholic and other extracts have proved toxic when fed to guinea pigs, but so far the actual toxic principle has not been identified. A protein fraction isolated from the plant was found to be non-toxic.

Ranunculacae.—The investigation of the poisonous principles of members of this Natural Order has been continued. The chemical and toxicological properties of an organic acid which has been isolated from *R. sceleratus* are being studied.

Lambs were grazed on plots of *R. repens* and *R. bulbosus* for four weeks and remained normal, whereas it had been found previously that both these plants given in sufficient quantity caused the death of rabbits.

Chick-weed.—A sheep ate 236½ lb. of chick-weed (*Stellaria media*) in 28 days and appeared to thrive on it. A rabbit was given 40 c.c. of the juice of the plant daily for 7 days without showing any ill-effects.

General.—During the year a number of cases of suspected plant poisoning have been investigated in Surrey, Cambridgeshire, Norfolk, Suffolk and Bedfordshire. In Kent an investigation of similar cases has been put in train in conjunction with the County Veterinary Advisor.

Title of paper issued during the year.

1. Blakemore, F.: The leucocytes of fowl blood with special reference to fowl paralysis. *Vet. Rec.*, **46**, 417, 1934.

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26. VETERINARY LABORATORY, MINISTRY OF AGRICULTURE AND FISHERIES

FOOT-AND-MOUTH DISEASE EXPERIMENTAL STATION, PIRBRIGHT.

(*Under the general direction of the Foot-and-Mouth Disease Research Committee.*)

During the year the examination of small animals killed or captured on premises connected with field outbreaks revealed a naturally contracted case of the disease in a hedgehog. The susceptibility of voles was studied, and further work with hedgehogs emphasised their value as experimental animals. A quantitative study was made of the distribution of the virus in the body at different stages of the disease, and considerable progress was achieved in the further investigation of the mechanism of natural transmission. The previous observations on the duration of acquired immunity in cattle and pigs were confirmed and extended, and further work was carried out on vaccination and on the properties of immune serum. A great deal of attention was paid to the question of the immunological types of the virus, and further evidence was obtained to support the suspicion that many of the virus strains occurring in the field are probably of a complex nature, containing components of two or more " types ". Progress was made in the development of methods of separating type components, both in naturally occurring complexes and in artificial mixtures of strains.

A further progress report of the Committee is in course of preparation.

VETERINARY LABORATORY, WEYBRIDGE.

Babesiasis and Anaplasmosis.—The African and South American strains were maintained. During the year ticks were received from East Africa, Northern and Southern Rhodesia, Trinidad, Jamaica and British Guiana. In all cases eggs were successfully hatched and numerous larvae obtained, and in all cases larvae were fed on susceptible cattle. No infections were set up by the bites of the ticks from Northern Rhodesia and British Guiana, but the cattle subjected to the bites of the ticks from the other four sources all developed an infection with *Babesia bigemina*. The failure in all cases to transmit an infection with *Anaplasma* is an interesting point which deserves further investigation.

Contagious abortion of cattle.—During the year 21,204 doses of the living vaccine were prepared and issued, and 1,243 agglutination tests were performed in connexion with questions of vaccination.

The supervision of the eradication work in selected herds, under the scheme promoted by the Agricultural Research Council, was continued, and in this connexion 2,330 agglutination tests were made. The examination of a large series of pigs' bloods for evidence of *Brucella* infection was concluded, and the results were published (1). These results suggested that the infection is present in a very small number of pigs in this country, although they did not definitely prove its existence; they certainly established the fact that there is no widespread porcine infection.

The work on the distribution of *Br. abortus* in the bodies of "carrier" cows was almost completed, and a report will shortly be published. Further work was carried out on the use of killed or modified cultures as vaccines, and also on the *Brucella* infections of horses.

Preliminary studies on the biochemical characteristics of *Brucella abortus* in relation to immunological reactions have been undertaken.

A popular leaflet was published, giving detailed information regarding infection and the steps to be taken for the eradication of the disease by blood-testing and isolation (2).

Tuberculosis.

Bovine.—A comparative study was started to assess the relative value of the tuberculin tests in common use (double intradermal, caudal fold and vulva tests) for the diagnosis of bovine tuberculosis.

A total of 1,336 tests was made, 424 at the laboratory and 912 in a large dairy herd. In connection with this work, 31 reacting cows were submitted to post-mortem examination and biological tests made of selected tissues.

Three cases of bovines infected with avian strains of the tubercle bacillus were recognised.

The observation of the influence of B.C.G. vaccine on the incidence of the disease in selected herds was continued, and during the year 947 doses of the vaccine were prepared and issued for this purpose.

Avian.—Observations were continued on a poultry farm with a flock of 6,000 birds, which had been heavily infected with tuberculosis. In 1931 the incidence of infection in the three-year old and four-year old birds was 26 and 34 per cent. respectively. The incidence of infection in 1933 was less than six per cent. This reduction was attained by discarding stock after the age of two years, the prevention of overcrowding, tuberculin testing and renting additional land in order to rest the old and heavily infected runs.

Parasitic gastritis of sheep.

(a) *Economic loss* (3).—Forty-three replies received to a circular letter addressed to 62 farmers on the Romney Marsh, showed that over 15 per cent. of their lambs died during the winter 1933-1934. Allowing for a 5 per cent. loss from other causes, it was estimated from the particulars supplied that the 43 farmers sustained a monetary loss of about £10,340 from parasitic gastritis. As the disease at that time was widespread throughout England and Wales, the total loss must have been very great.

(b) *The effect of nutrition upon the acquisition and elimination of infection* (3).—By means of weekly estimations of the number of eggs passed in the faeces, comparisons were made between sheep receiving a full diet and others receiving an inadequate diet. It was found that the giving of an inadequate diet resulted in an increase in the rate at which an experimental infection was acquired, and greatly retarded the rate of elimination of an infection already present.

(c) *The viability of the eggs of* Trichostrongylus *spp. under drought conditions.*—The eggs of these worms are exceedingly resistant to dryness when at the stage in which they are just ready to hatch. Experiments were carried out to ascertain whether dews provided sufficient moisture to enable development to proceed to the infective stage, or only enough to cause the eggs to hatch and the larvae to enter upon a non-resistant stage, and so to lead to their ultimate destruction. It was found that the effect of the amount of moisture in the dew was slight, and it was concluded that under drought conditions at pasture there is a gradual storage of potential infective material on the ground, and a mass liberation of infective larvae takes place when wet weather arrives.

(d) *Treatment by intravenous medication.*—The effect of the intravenous injection of 16 different drugs was tried, using rabbits infected with a species of worm closely allied to those which cause parasitic gastritis in sheep, but the results obtained did not give any promise of success from this line of treatment.

(e) *The epidemiology of the series of outbreaks which occurred in the winter of* 1933-1934 (3).—A study was made of the type of disease and the causes leading up to the epidemic. Species of *Trichostrongylus* were found to be chiefly concerned, and the enquiry led to the conclusion that the prolonged drought was responsible; the bare pastures resulting in a maximum intake of larval worms, the scanty herbage of a low nutritive value causing a breakdown in the immunity of the sheep, and the continued dryness bringing about a storage of embryonated eggs of *Trichostrongylus* spp. (potential infective material which developed to infective larvae *en masse* when wet weather supervened).

(f) *Diagnosis* (4).—A simple method has been worked out of estimating the numbers of trichostrongylids present in the stomach and small intestine of sheep suffering from parasitic gastritis. Numbers of these estimations have been made in affected sheep, and it has been shown that this procedure is a valuable aid to diagnosis, particularly in adult animals, where, as has been shown (4, 8), the egg count is unreliable because the immunity responses of the host may depress the egg production of the worms very materially.

Syngamiasis.—From further feeding experiments it appeared that *Syngamus* larvae may retain their infectivity within the earthworm for more than three years and six months.

Experiments have shown that various species of slugs and snails are able to act as true intermediate hosts for this parasite, the larvae occurring in the muscular parts, in the liver and in the body cavity.

An instrument has been devised by means of which the gapeworms can be extracted from the trachea; the procedure is a simple one, and the removal of all the worms, with complete cure, can usually be effected in half a minute. The treatment should prove equally efficient in young pheasants.

Fimbriaria fasciolaris associated with disease in swans (5).—A number of *F. fasciolaris* were recovered from the proventriculus of a swan; their presence in this situation, which is a very unusual one for any tapeworm, was found to be associated with lesions and bacterial invasion of the tissues. Six swans had died and twelve others were severely affected.

Salmonella infections in poultry.—Infection with *B. aertrycke* has been studied particularly in ducks, and a report will shortly be published embodying the observations made on the mortality in ducklings, the detection of adult " carrier " ducks, and the occurrence of the organism in the ovary and in eggs.

B. aertrycke infection has also been encountered in chickens, pheasants and poults.

Newcastle disease.—The study was concluded of the virus obtained from the single outbreak of the disease which was detected in 1933. The virus differed considerably from the strains previously encountered in this country, and in particular the mortality associated with both natural and artificial infection was very much lower, although still serious. Another unusual feature was the occurrence of an apparent (although only partial) " age-immunity." A report is being prepared for publication.

Fowl cholera.—In 1934 an outbreak was recorded of a form of fowl cholera which is believed to be very uncommon. This form of the disease, which was first recorded in Australia in 1914, is characterised by lesions of the wattle, and these may vary from a simple swelling to a wrinkled condition associated with the presence of areas of necrosis. The disease on the farm occurred only in male birds, and at the laboratory it passed readily to healthy male birds placed in contact with the affected. A report will shortly be published.

Metabolism of arsenic.—Work commenced last year on the fate of injected arsenic in the turkey, in relation to therapeutic treatment of " blackhead " and subsequent marketability of the carcase, has been completed for early publication.

Metabolic disorders of farm animals.—The work of the previous year on lactation tetany of cows has been expanded to include any disorders of which hypomagnesaemia is a feature. Co-operation with the National Institute for Dairy Research at Reading has been established in respect to blood studies on the clinically normal cow throughout the sexual cycle, and data so acquired are correlated with data obtained through blood samples sent in by veterinary practitioners from cows suffering from diagnosable metabolic disorders.

Blood studies on the horse and sheep are also being made from the biochemical point of view.

In cattle (11) it appears that at parturition in the normal cow there is a slight fall in blood calcium and a rise in magnesium, followed by a rise in calcium and fall in magnesium, and finally a return to normal. If these changes are exaggerated, typical " milk fever " appears; this can be cured by any treatment which raises the blood calcium for a sufficient time.

The blood calcium and magnesium contents in lactating cattle may be altered by other factors, e.g., sudden change of environment or nervous disturbance. Hypomagnesaemia without hypocalcaemia produces tetany described as " lactation tetany " : this does not usually occur until some time after calving, and can be cured by any treatment raising the blood magnesium—the usual method is a large injection of magnesium sulphate solution.

A simultaneous fall of blood calcium and magnesium produces a condition diagnosed variously as " atypical milk fever," " atypical lactation tetany," or " tetany of unknown origin " : there is no proper name. Injection of calcium and magnesium salts, or inflation of the udder, produces good results, but research is needed on methods of diagnosis.

Chronic hypomagnesaemia is known, but is rarely clearly recognisable.

In horses similar conditions occur, but are less serious. "Transit tetany" of Welsh mountain ponies is a combined hypomagnesaemia-hypocalcaemia.

Hypomagnesaemia has been observed in ewes.

None of the above disorders are directly due to nutritional factors: they are due to derangement of the physiological regulatory mechanisms rather than to dietary deficiency.

Other metabolic disorders (e.g., acetonaemia, pregnancy toxaemia) are also under investigation.

Diseases associated with mineral imbalance or deficiency.—Certain work has been carried out in loose association with observers in other parts of Britain and of the world. A publication in collaboration with Sir A. Theiler (12) was compiled as a sequel to the earlier "L'Aphosphorose chez les ruminants" by the same authors.

Titles of papers issued during the year.

1. Doyle, T. M.: A survey for the presence of *Brucella* agglutinins in pigs' blood in Great Britain. *J. Comp. Path. and Thera.*, **47**, 2, 134-140, 1934.
2. ———: Bovine contagious abortion. *J. Min. Agric.*, **40**, 6, 491-505, 1933.
3. Taylor, E. L.: The epidemiology of winter outbreaks of parasitic gastritis in sheep, with special reference to outbreaks which occurred during the winter of 1933-1934. *J. Comp. Path. and Thera.*, **47**, 4, 235-254, 1934.
4. ———: A method of estimating the number of worms present in the fourth stomach and small intestine of sheep and cattle for the definite diagnosis of parasitic gastritis. *Vet. Rec.*, **14**, 18, 474-475, 1934.
5. ———: *Fimbriaria fasciolaris* in the proventriculus of a swan associated with bacterial infection and ulcer formation. *Parasit.*, **26**, 3, 359-360, 1934.
6. ———: The production of malformed eggs by immature *Fasciola hepatica*. *Trans. Roy. Soc. Trop. Med. and Hyg.*, **27**, 5, 499-504, 1934.
7. ———: The epidemiology of parasitic gastritis in sheep. *J. Agri. Sci.*, **24**, 2, 192-208, 1934.
8. ———: Field experiments on the immunity of lambs to parasitic gastritis caused by a mixed infection of trichostrongylid nematodes. *J. Helminth.*, **12**, 3, 143-164, 1934.
9. Dobson, N.: Some poultry diseases. *Vet. Rec.*, **14**, 332-336, 1934.
10. ———: The control of poultry diseases. *Ibid.*, **14**, 1354-1356, 1934.
11. Allcroft, W. M., and Green, H. H.: Blood calcium and magnesium of the cow in health and disease. *Biochem. J.*, **28**, 2220-2228, 1934.
12. Theiler, Sir A., and Green, H. H.: Les dystrophies osseuses des animaux domestiques. *Office Internationale des Epizooties*, 1934.

27. ANIMAL DISEASES RESEARCH ASSOCIATION, EDINBURGH

Tick-borne fever.—It has been found that the infective agent is present in high concentration in the white corpuscles, which give a positive reaction at very high dilutions. The other components of the blood contain little if any of the infective agent.

The infective agent has been found to remain alive at room temperature and at cold room temperature for a period of 16 days.

Louping-ill.—It was again found that a vaccine prepared from formalinised brain and cord and spleen suspensions was capable of reducing the mortality incidence markedly.

Pregnant ewes have been hyperimmunised with louping-ill virus with the object of determining whether antibodies are transmitted to their offspring either before birth or through the medium of the colostrum after birth. The virucidal factor in the serum of the vaccinated ewes was demonstrated only with difficulty and no antibody was detected in the serum of the lambs at birth. The colostrum of the ewe contained a demonstrable quantity of antibody and, several hours after the lamb had sucked its immune mother, antibody was detected in the serum of the lamb. Immunity in the lamb is, of course, passive in character, and there is evidence that it drops below the detectable level after a period of 10 days. These experiments require further confirmation.

Braxy.—The vaccine continues to prove highly satisfactory as a prophylactic measure.

During 1933-34, a controlled field experiment to test the comparative efficacy of single and double dose methods was undertaken. Approximately 4,500 hoggs received the single inoculation and a similar number were inoculated twice. The result, although not conclusive, suggests that the single inoculation method furnishes an adequate degree of protection.

For many years certain flockmasters have administered pig dung as a braxy prophylatic. The efficacy of this was tested against braxy vaccine, with a third group of sheep as a control. The sheep were kept under comparable conditions. It was found that, although the group to which pig dung was administered was afforded a measure of protection, the incidence of braxy in this group was much higher than in that which received the vaccine.

Scrapie.—A systematic histological investigation of the tissues in scrapie is being continued.

The field experiment which was set up for the purpose of testing the possibility that the contagium of scrapie may be transmitted through the medium of the grazings has now been in progress for two years. The result, so far, has been negative.

Grass sickness (7).—The presence of the toxin of *Cl. Welchii* (Type D Wilsdon) has been demonstrated in filtrates of the intestinal contents of certain acute cases of grass sickness.

Contagious bovine abortion.—The research on contagious bovine abortion has, as its ultimate object, the development of effective immunogenic methods. The work so far has been carried out upon small laboratory animals. Several field strains of *Brucella abortus* have been tested for their comparative pathogenicity and, in this respect, have been found to present marked variation. A criterion of infection has been defined using a specially selected virulent strain, and the most appropriate infective dose of this strain has been determined.

Enzootic abortion in ewes.—As previously reported, the results of field experiments indicated that the administration of vitamins A, D and E was followed by a marked reduction in the abortion rate as compared with that of the controls. The number of test animals was, however, limited, and the investigation was, last season, extended to six farms. With the exception of one group in which no cases of abortion occurred after administration of vitamin E, the results were irregular and were without statistical significance.

Lactation tetany and magnesium metabolism.—The investigations carried through in 1931-32 showed that a hypomagnesaemia was consistently present in lactation tetany, and it was further found that the parenteral administration of salts of magnesium, when applied during the early phase of the disease, effects a cure.

A survey is now being made of the seasonal variations, if any, which occur in the blood magnesium of milch cows.

Pine (1).—A condition of pine has been found to affect sheep on extensive areas of hill grazing in the Cheviots. In conjunction with the Edinburgh and East of Scotland College of Agriculture, arrangements have been made for the systematic investigation of this condition.

Ixodes ricinus (5).—The ecological studies on *Ixodes ricinus* are being continued with specal reference to the effect of climatic factors on the survival and activity of unfed ticks. It has been found that unfed ticks can survive only within very narrow limits of humidity—80 per cent. to 100 per cent. saturation of the air—at a temperature of between 15° C. and 30° C. These were also found to be the limits of humidity necessary for development of the gorged tick as distinct from the activity of the unfed tick. These conditions of moisture obtain in nature only under definitely limited conditions of soil and vegetation, and it would appear that the local distribution of ticks in areas of suitable climate is thus governed by their humidity requirements, these confining them to mossy ground over which there is a depth of rank or old vegetation. The seasonal occurrence of the tick would appear to be mainly governed by temperature.

The study of the bionomics of the tick has been carried through with the ultimate object of obtaining rational means of control or eradication of this pest. A survey of possible methods of control, in the light of the available knowledge of the bionomics of the tick, indicated that the most practicable methods were those involving the use of a tick repellant dip. As a result of preliminary experiments with different dips, it was found that an arsenic-carbolic dip, with which wool fat was incorporated, exerted the most marked repellant effect on ticks. Under the conditions of the experiment in which this dip was tested, the repellant effect remained apparent for a period of from two to three weeks.

Blowfly myiasis.—An investigation upon the sheep blowflies has been initiated. Collections of larvae have been made from numerous cases of " strike ", with the primary object of identifying the species of flies involved. Preliminary field observations on the incidence and distribution of strike have been made.

Demodex folliculorum var. ovis.—It has been established that there occurs in sheep in this country a type of *D. folliculorum* which presents certain morphological differences from those varieties of the species previously described as occurring in sheep. The parasite more commonly affects debilitated as distinct from healthy sheep, but it appears to be of little or no pathogenic significance.

Titles of papers issued during the year.

1. Greig, J. R.: Pine: A disease affecting sheep and young cattle. *Scott. J. Agric.*, **16**, 3, July, 1933.
2. Gordon, W. S.: The control of certain diseases of sheep. *Vet. Rec.*, **16**, 1, 1934.
3. ———: Louping-ill. *Proc. Roy. Soc. Med.*, **27**, 11, 1934.
4. ———: Comparative aspects of louping-ill in sheep and poliomyelitis of man. *Brit. Med. J.*, 19th May, 1934.
5. MacLeod, J.: Ixodes ricinus in relation to its physical environment. The influence of climate on development. *Parasit.*, **26**, 2, 282, 1934.
6. Dryerre, H.: Biochemistry in its relation to veterinary research and practice. *Nat. Vet. Med. Assoc. Cong.*, Edinburgh, 31st July, 1934.
7. Gordon, W. S.: Entero-toxaemia in herbivorous animals: Its possible bearing on grass sickness in horses. *Nat. Vet. Med. Assoc. Cong.*, Edinburgh, 31st July, 1934.

28. VETERINARY RESEARCH DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

Abortion.—In last year's report reference was made to the use of a new type dead vaccine and its method of preparation given. Encouraging reports on the use of this vaccine continue to be received from veterinary surgeons, but owing to the fact that no control animals have been left in the herds in which it has been used, one is unable to appraise the exact value of the vaccine. During the past year a large herd has been placed at our disposal for experimental purposes. The result of a blood test and a history of several abortions indicates that infection is widely spread through this herd. Vaccination has been carried out, leaving controls and will be continued for a few years when a report will be issued.

Tuberculosis.—The experiment with Spahlinger's anti-tuberculosis vaccine has been completed and the report will be issued shortly. The results have been very favourable.

ANIMAL NUTRITION AND ANIMAL BREEDING

29. ANIMAL NUTRITION RESEARCH INSTITUTE, CAMBRIDGE UNIVERSITY

CHEMISTRY.

During the past year investigations of changes occurring during growth in pure cultures of grasses, especially perennial ryegrass, wild white clover, etc., have been continued.

As previously stated, the changes have been followed by methods designed to ascertain under what circumstances and at what stages in the growth the produce is most highly equipped with substances of major importance as metabolites if used as fodder.

In the case of perennial ryegrass, the plot was kept free from weeds (including other grasses) and held in commission as long as possible. During the first two or three seasons specimens were taken at frequent intervals up to full growth development and from second, third and fourth cuts from the same patch in the same season. Later, specimens were taken from the same old ley after manuring parts with farmyard manure and with successive top dressings of ammonium sulphate, in order to obtain material for (*a*) confirmatory purposes, (*b*) isolations, (*c*) further investigation of any specially interesting growth phase, and (*d*) for testing out improvements in the scheme or its component methods as these were evolved.

The procedures had of necessity to be evolutionary and numerous side investigations have been carried out in order to arrive at proper interpretations.

It is firmly believed that no quantitative investigation of plant material can be satisfactory unless the quantity-balance-sheet-process is continuously employed for checking the results. In this way the importance of obviating as far as possible certain difficulties inherent in all such investigations but not generally regarded as of much moment, became evident. Such problems as contamination of specimens by soil, and the adverse and indefinite effects of heat in drying operations on total organic matter determinations necessitated much further careful enquiry.

Progress has been made in the development of the new method for the accurate estimation of Fehling reducing substances when present in very small quantities. As previously stated, it was found that departure from accuracy, in the case of estimates obtained by methods commonly used, is progressively greater as the concentration falls from the equivalent of 15-20 milligrammes of glucose in the quantity of solution conveniently available. The new method has already given valuable assistance. It has been necessary to carry out numerous estimates by the older methods in order to prepare a graph for correcting those early estimates of the grass investigation that were lower than the 15-20 milligramme limit.

NUTRITION.

Pasture research.—The results of the work on the value of grazing for pigs have been published. The data from these trials enable, for the first time, a quantitative expression to be made of the food requirements of pigs (including in-pig sows) when on grass (20, 22).

The work on the composition and nutritive value of winter pasturage, in which, for the first time, the yield, composition and digestibility of winter grass have been determined, was completed during the past year. An account of the work has been published (24).

Six seasons of work have now been completed on the problem of the influence of intensive fertilising on the yield, composition, and feeding value of permanent pasture. The results of the first two years' work only have so far been published. The main object of the past season's work was to ascertain the residual effects, if any, of the fertilisers, including sulphate of ammonia, applied continuously during the first five years of the trials. Accordingly, no fertilisers, beyond the farmyard manure applied during the preceding autumn, were used in the 1934 trials (19).

Lucerne investigations.—The second stage of these investigations has been completed and the results published during the past year. It consists of a study of the influence of systematic cutting at three different stages of growth (pre-budding, budding and early-flowering) on the yield, composition and nutritive value of lucerne. It is shown that the main distinction in nutritive properties between lucerne and grass is the readiness with which the young lucerne plant produces fibre, and the early stage of growth at which the fibre begins to display signs of lignification and diminished digestibility.

Lucerne resembles grass in displaying its highest digestibility at the earliest stage of growth, at which stage also the dry matter of the crop is richest in starch equivalent and digestible protein. The dry matter of pre-budding lucerne approximates more closely to the protein-rich concentrate than to the coarse fodder. In respect of digestible protein, it is equal to the dry matter of young grass at its best, but it is inferior as a source of starch equivalent. The problem as to whether it is advisable to cut lucerne continuously at an early stage (particularly for the purpose of lucerne meal manufacture) is discussed fully in the paper (21, 23).

Work on the composition, digestibility and nutritive value of lucerne hay, lucerne meal (English and American) and lucerne leaf meal (American) has been carried out during the past year, and an account published (25).

Sheep nutrition.—Feeding trials, under strictly controlled conditions, to determine the capacity for consumption (in terms of lb. dry matter) and the starch equivalent requirements for maintenance of sheep at all stages from weaning to 200 lb. live-weight have been carried out continuously during the past year and are still proceeding. The experiments are being made under out-door conditions on typical winter rations. The results are intended as a check on the existing sheep-feeding standards, which have been subjected to considerable criticism in recent years.

During the past summer, attempts have been made to measure the capacity for consumption of sheep of differing live-weight on pasturage of varying quality. A new technique has been followed for this purpose. The grazing sheep wear a light harness permitting collection of faeces in a water-proof bag. The faeces are weighed from day to day, and composite samples are analysed. Contemporaneous determinations of the digestibility of the grass are made on other sheep kept in metabolism cages, and with the data thus available, it is possible to calculate the mean daily consumption of the grazing sheep.

Ruminant digestion and the utilisation of cellulose.—These investigations had their origin in a proposal to use the reaction between cellulose and cellulose-splitting bacteria as the basis of a simple " in vitro " method of determining the digestibility of the fibre of feeding stuffs, thus enabling the laborious method of digestion trials to be dispensed with. The hopes in this direction were not realised, the reasons for this being contained in an earlier publication dealing with the action of cultures of such bacteria on feeding stuffs and the fibre separated from the feeding stuffs.

As a result of further work, we are now inclined to abandon the cellulose to glucose hypothesis, and to focus attention on the possible formation, in digestion, of fat-precursors such as lactic acid and pyruvic acid. During the past year, studies of the activity of cultures of cellulose-splitting bacteria on cellulose, both at 37 and 65° C., have been made, together with studies of the breakdown of starch and glucose under similar conditions. Definite evidence of the production of lactic acid and pyruvic acid has been obtained, these acids being preceded by glucose, cellobiose and probably forms intermediate between cellulose and cellobiose. Under " in vitro " conditions, lactic acid appears to undergo quick transformation into CO_2 and fatty acids, such as acetic, butyric and formic acids.

Kale trials.—Trials of the yield, composition and nutritive value of marrow stem kale and thousand-head kale have been commenced recently.

CALORIMETRY.

The experimental work on the metabolism of hogs has been practically completed during the year, only two experiments remaining to be done, and these will be completed within the next month. The computations in connexion with this work are also in an advanced state and one paper has been published (2).

The building and testing of the calorimeter for poultry has progressed. The heat registration which, as mentioned in previous reports, had given considerable trouble, was finally brought to a satisfactory state of accuracy last May. Since this time attention has been focussed on the water vapour balancing mechanism, and although some difficulties have naturally been encountered, every hope is entertained that this also will shortly be in a satisfactory state and the instrument ready for use with birds for determining the metabolism by direct calorimetry.

POULTRY NUTRITION.

Although the function of the Poultry Nutrition Section is one of research, advice has been given on a number of enquiries of such a nature as to require technical knowledge of a research character. A point of interest that has emerged as the result of the giving of this advice is the close correlation that apparently exists between conditions of malnutrition and the prevalence of certain diseases, particularly in the case of coccidiosis and certain troubles that are often loosely designated as fowl paralysis. The analysis of 40 Light Sussex Cockerels has been completed, and the data so obtained will be subjected to statistical treatment.

A report on the work carried out on the composition of the egg fat and the depot fat of the fowl, as affected by the ingestion of large amounts of different fats, has now been published (27). The evidence thus obtained enables one to predict with confidence the effect on the quality of both the egg and the carcase by the inclusion of fats of definite types in the dietary of fowls.

Preliminary work on the effect of hatchability of eggs with varying fat composition indicated that the eggs from hens fed on the soya bean oil diet gave a better hatchability than those derived from hens fed on other fats, but owing to the small number of birds available and the absence of accommodation, this experiment could not be carried to a statistically significant conclusion.

The analytical material for the study of the effect on the composition of the body fat of foods of cereal origin has now been accumulated and is awaiting analysis.

Evidence obtained by the analysis of the Bedfordshire County egg laying trials indicated that the digestible protein required for egg production is lower than the hitherto accepted figures (26).

Owing to the insecurity of our knowledge in this respect, a new method of rationing for commercial egg production has been devised. This method automatically corrects any inaccuracies of the standards and the variability introduced by local conditions.

In connection with the studies in egg quality, a series of analyses is now in progress to ascertain to what extent variation in composition of eggs occurs, both in eggs of individuals of the same breed, and eggs of individuals of different breeds.

POULTRY GENETICS.

During the year under review, the poultry breeding plant has been fully occupied with work on the improvement of the Cambar. In 1933, 600 pure bred Cambars and 750 cross bred birds were hatched, the latter being mostly Barred Rock F_2 and back-cross birds. From these eventually 260 Cambar pullets went into the recording pens. It will be understood that in the case of the F_2 and back-cross birds only one-quarter and one-half respectively of the progeny even approximately reproduced the Cambar pattern, and that these proportions were still further reduced by the culling of " off " marked birds.

As regards egg scores, unfortunately complete records of all the birds are not available, since only those pullets were retained for the whole year which seemed likely to be possible parents for 1935. It is true that in this way experimental data of considerable interest may be lost; but if the object is to produce the improved Cambar at the earliest possible opportunity, then clearly the best use of limited accommodation can be got by the earliest possible rejection of all but the best birds.

Up to now, nine birds have laid over 200 eggs in the egg-recording year, and several others have laid quite remarkably large tinted eggs. While it is clear, then, that some good birds of this breed exist, it is, unfortunately, true that there are still far too many of indifferent quality. Further selection and some more introduction of " fresh blood " will be required to bring the stock up to a standard which the practical breeder would regard as reasonable.

PHYSIOLOGY.

In order to make the best use of the limited accommodation available for the larger animals, work has proceeded on several different lines so that, although each will take some time to work out, the material available will be used to the best advantage.

Cattle.—Investigations on the methods of treatment of sterility in cattle have been commenced, sterile cows being given or loaned by their owners to the research station for the purpose of study. Tests on methods of diagnosis of pregnancy are being made on those which have been cured. Incidental observations on the occurrence of bull-dog calves and the rate of hair growth are also being made. After normal calving the cows are being used for experiments on artificial insemination, e.g., ascertaining how long the fertilising capacity can be retained by the sperm when kept outside the body, and improving the technique of artificial insemination.

Horses.—The first results from the reciprocal crosses between Shire horses and Shetland ponies, made by means of artificial insemination, have been obtained. Growth rates and the development of body proportions and thickness of bone in these reciprocal crosses are being studied.

Sheep.—With sheep the duration of the natural breeding season has been investigated by the use of a sterile ram; lambs can be produced, if so desired, from January to August inclusive. An attempt to obtain fertility in the non-breeding season (April to July), by means of shortening the length of day, was not successful.

Rabbits.—The colony of rabbits, which is used to test out new principles and theories in reproduction and growth before their application to the more expensive animals, has been used mainly for studying the changes occurring during pregnancy and the relative growth of different parts of the body. A new method for the control of sex (acid and alkali as affecting the two sorts of sperm differently) has been put forward: this has been tested and found to be ineffective.

Butter fat.—Statistical investigations of the factors affecting the colour of butter fat have been made on observations obtained at the Dairy Show; colour scales have been used for measuring the colour of butter and the body fat of carcases in cattle. The mean values and variability curves for the fat colour in the different breeds of cattle have been obtained. Statistical investigations on the factors affecting butter fat production have also been made from Dairy Show records; similar studies on records obtained from herds throughout the country at different times of year are being made. The linking up of the work at the Institute with the activities of Breed Societies and organisations for the improvement of live stock and animal production has also been undertaken.

Meat.—A study of the factors affecting the quality of beef, mutton, pork and bacon has been continued. Mr. Hirzel (attached to the Institute from the University of Stellenbosch, Union of South Africa) has worked out the measurements of muscle, fat and bone in mutton carcases from the different breeds of sheep and has compared them with the requirements of the public as judged by the average measurements of prizewinners in the Carcase Classes at Smithfield Show. A scale of points (largely based on measurements) has been drawn up for use in judging New Zealand frozen pork carcases. Colour scales have been used for measuring the colour of meat. Mr. Watson (attached to the Institute from the Council for Scientific and Industrial Research), working in conjunction also with the Department of Biochemistry in the University has, after isolating the haemoglobin colouring matter from muscle, compared its properties with that derived from blood, in order to obtain a method of estimating it chemically: the importance of this lies in the fact that the colour is closely associated with the flavour of meat. Work in co-operation with the Low Temperature Research Station is also in progress on the factors affecting the quality and colour of fat and muscle.

Dr. Fraser (attached from the Rowett Institute of Animal Nutrition, Aberdeen) has been making some preliminary experiments on nutrition in relation to wound healing, and is working out the results of his studies on sheep in Scotland.

Titles of papers issued during the year.

1. Cruickshank, E. M.: Observations on the feeding of different fats to poultry. *Agric. Prog.*, **11**, 147, 1934.
2. Deighton, T.: A study of the fasting metabolism of hogs. I. Age, weight and length data, etc. *J. Agric. Sci.*, **24**, 326, 1934.
3. Edwards, J.: Register of merit for bulls. *Dairy Shorthorn J.*, No. 2, 4, 1934.
4. ———: Schemes for dairy cattle improvement in Great Britain. *Proc. 10th World's Dairy Cong.*, Rome, 1934.
5. ———: Recent research and experimental work with pigs. *Pig Breed. Ann.*, **13**, 135, 1933-34.
6. Halnan, E. T.: The work of the Poultry Nutrition Research Institute, Cambridge. *Agric. Prog.*, **11**, 144, 1934.
7. Halnan, E. T., and Cruickshank, E. M.: Some aspects of fat metabolism in fowls and their practical significance. *Proc. 5th World's Poultry Cong.*, Rome, 1933, Paper No. 54.
8. Hammond, J.: Problems of feeding and management in pig production. *Vet. J.*, **90**, 98, 1934.
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10. ———: Conformation and development of the bacon pig. *Agric. Prog.*, **11**, 127, 1934.
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12. ———: The inheritance of fertility in the rabbit. *Rept. 6th Ann. Rabbit Conf.*, Harper Adams Agric. Coll., Aug., 1934.
13. ———: Fertility in poultry. *Rept. 18th Poultry Breed. Conf.*, *Ibid.*, Aug., 1934.
14. Hammond, J., and Murray, G. N.: Grading meat: the prices given for carcasses of different weights and qualities. *J. Agric. Sci.*, **24**, 233, 1934.
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17. Walton, A.: The technique of artificial insemination. Oliver & Boyd, 1933.
18. Whetham, E. O.: Tables showing the carcase weight, carcase percentage and age in relation to the live weight of pigs. *Pig Breed. Ann.* **14**, 188, 1934-35.
19. Woodman, H. E.: When nitrogen pays on grass. *Farmer and Stockbreeder*, Feb., 1934.
20. ———: The value of grazing for pigs. *J. Min. Agric.*, **40**, 1139, 1934.
21. ———: Composition and feeding value of lucerne. *Ibid.*, **41**, 137, 1934.

22. Woodman, H. E., and Norman, D. B.: Nutritive value of pasture. X. The utilisation of young grass by swine. *J. Agric. Sci.*, **24**, 93, 1934.
23. Woodman, H. E., Evans, R. E., and Norman, D. B.: Nutritive value of lucerne. II. Investigations into the influence of systematic cutting at three different stages of growth on the yield, composition and nutritive value of lucerne. *Ibid.*, **24**, 283, 1934.
24. Woodman, H. E., and Oosthuizen, P. M.: The composition and nutritive value of winter pasturage. *Ibid.*, **24**, 574-597, 1934.
25. Woodman, H. E., and Eden, A.: The composition, digestibility and nutritive value of lucerne hay, lucerne meal and lucerne leaf meal. *Ibid.*, **25**, 50-70, 1935.
26. Halnan, E. T.: The scientific principles of poultry feeding. *Bull. No.* 7., *Min. Agric.*
27. Cruickshank, Miss E. M.: Composition of the egg fat and the depot fat of the fowl. *Biochem. J.*, **28**, 965, 1934.

30. ROWETT RESEARCH INSTITUTE, ABERDEEN

Nutrition and disease.—Investigations on the influence of nutrition on the incidence of disease have been continued. Working with large numbers of small animals it has been shown that animals which had been kept for a long time on an ill-balanced ration are much more susceptible to certain infections than similar animals receiving the same rations but supplemented by milk and green food which make good deficiencies in the ill-balanced ration. The influence of vitamin A deficiency has been studied in the rat, and it has been found that lesions in the intestinal tract due to the lack of vitamin A occur earlier than has been supposed, and have a profound effect upon the nutritional state of the animal.

Blood composition.—In dairy cattle and sheep the changes in the composition of the blood throughout the course of pregnancy and lactation, and the effect of the nature of the diet on the composition of the blood have been studied. This work will be continued over a series of years to ascertain whether the marked effects of the nature of the diet on the incidence of disease noted in small animals occurs also in these farm animals.

Physiology of the fowl.—Work on the calcium and phosphorus metabolism and the phosphatase level of blood and tissues of the fowl, with special reference to egg laying, indirect calorimetry in the fowl and the studies on carbohydrate metabolism referred to in previous reports have been continued.

Feeding experiments.—On the Duthie Farm a number of small experimental wooden silos were filled with green fodder and treated with different materials, e.g., molasses and "A.I.V." acid preparation, to test the relative efficiency of different methods of conservation. Some useful information has been obtained on the influence of the method of preservation on the chemical composition, and some experience has been gained in making silage by various methods with potatoes and cabbages.

Feeding trials were carried out with dairy cows comparing artificially dried clover meal made in this country with imported alfalfa meal. The results seemed to show that the former gives a stimulus to milk production and increases the yellow colour, i.e., the carotene content of the milk. Experiments to test the value of young pasture grass dried artificially in Scotland have been begun.

The work on the economic management of dairy cows on temporary pastures has been continued. In tests in which the amount of grass eaten was measured, it has been found that low yielders (2 to 3 gallons per day) ate as much grass as high yielders. Further work is being done to test the effect of the rationing of grass either by limiting the amount of time allowed for grazing or by feeding weighed amounts of grass.

A series of practical experiments testing the value of various rations have been carried out with pigs in conjunction with the Colleges of Agriculture in Scotland. These trials have shown that crushed oats may be used to replace sharps, barley and maize up to 65 per cent. of the total ration. The results of a series of feeding tests indicate that different levels of food consumption, i.e., allowing the animals to eat ad lib. or rationing according to age or rate of increase in weight, affect the economy of production and the quality of the grass. This work is being continued.

In conjunction with the North of Scotland College of Agriculture a pig recording litter testing scheme has been organised. The work is proceeding satisfactorily, and it is hoped that results of immediate practical value to pig feeders will be obtained.

The feeding experiments under the direction of the Joint Poultry Research Committee for Scotland and Northern Ireland, are being continued. The main object of the investigation in the past year has been the optimum level of protein for laying birds. Observations continue to be made on the influence of feeding on diseases in growing chicks.

Worm infestation of sheep.—During the past year, the most interesting work has been that on worm infestation of sheep, done in conjunction with the Zoology Department of the North of Scotland College of Agriculture. Further data have been obtained on the incidence of different kinds of parasites in different districts in Scotland and under different conditions of feeding and management.

Pasture research.—At Garrochoran the feeding experiments have been continued with the more expensive methods of feeding eliminated, and a reduction in the amount of blood testing. The work during the past year has, therefore, consisted mainly of the routine collection of data under the simple experimental conditions which were introduced two years ago. The data being collected are on similar lines to those obtained in previous years.

The results which were obtained in Garrochoran on the influence of feeding on the immunological reactions are in the meantime being tested on an extensive scale with rats.

During the year a number of animals in each of the different groups have been killed and the stomach and intestines taken to the laboratories, where the parasitic worms are being identified and counted.

Bovine abortion.—Work on this investigation started in February, 1934. Farms were chosen whose owners stated they were willing to co-operate, and an attempt made to carry out the segregation scheme.

Where the farmer's promise of co-operation was implemented, milking and segregation were efficient, the incidence of abortus infection was decreased, but, in other cases, all efforts on the part of the workers at the Institute proved unavailing to control the spread of the disease.

The causes of failure in such cases may be roughly classified as follows :—

(i) Insufficient staff on the farms to carry out the additional work entailed by efficient segregation.

(ii) Insufficient byre accommodation to ensure efficient segregation.

(iii) The introduction into the herd of untested dairy cows in order to maintain the milk yield.

The experiments on eradication are being continued on the farms where there is some prospect of success and arrangements are being made to carry out a series of tests to ascertain whether immunity can be conferred by dead vaccines.

Influence of feeding on the composition of the blood and milk of dairy cows.—During the past twelve months, further data have been collected by Dr. Tocher and his assistants on the freezing point of milk, using Hill's Vapour Pressure Method, and working with samples of milk from the herd of the Duthie Experimental Stock Farm. The work has been designed to obtain information as to the individuality factor in the case of cows all on a uniform ration; as to the day to day variation in the results for individual cows; and as to the relative results by Hill's method, and the Hortoct method. The supervision of this work has now been taken over by the Institute, and a herd of fourteen cows are being used as the experimental animals for the continuation of this work. The data being collected should give definite results with regard to the effect of feeding on the composition of the blood and of the milk, and it is hoped that the results will give some further information on the effect of feeding on the susceptibility of dairy cattle to certain diseases.

Titles of papers issued during the year.

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2. Henry, K. M., Magee, H. E., and Reid, E.: Some effects of fasting on the composition of the blood and respiratory exchange in fowls. *J. Exp. Biol.*, **11**, 58-72, 1934.
3. Allcroft, W. M.: Diurnal variations in the blood-sugar level of the lactating cow. *Biochem. J.*, **27**, 1820-1823, 1933.
4. Fraser, A. H. H., and Nichols, J. E.: Wool-growth in sheep as affected by the carbohydrate-content of the diet. *Empire J. Exp. Agric.*, **2**, 9-19, 1934.
5. Fraser, A. H. H., Godden, W., and Thomson, W.: The effect of a calcium deficient diet on pregnant ewes. *Vet. J.*, **89**, 408-411, 1933.
6. Thomson, W.: The effect of an iodine supplement in the ration of dairy cows. *Ibid.*, **90**, 48-51, 1934.
7. Fraser, A. H. H., Godden, W., and Auchinachie, D. W.: On methods of determining the degree of calcium deficiency of sheep. *Biochem. J.*, **28**, 157-161, 1934.
8. Blissett, A. H.: (A) Producing healthy pigs. *Young Farmer*, June, 1933.
   (B) Care of the sow. *Ibid.*, Sept., 1933.
   (C) The sow and litter. *Ibid.*, Dec., 1933.
   (D) The feeding pig. *Ibid.*, March, 1934.
9. Orr, J. B., Fraser, A. H. H., and Robertson, D.: The problem of parasitic roundworms in sheep. *Trans. Yorks. Agric. Soc.* (1933), No. 91, 35-38, 1934.
10. Strand, R., Anderson, W., and Allcroft, W. M.: Further studies on the lactic acid, sugar and inorganic phosphorus of the blood of ruminants, (a) following adrenalectomy and (b) after intravenous injection of insulin. *Biochem. J.*, **28**, 642-649, 1934.
11. Orr, J. B., Fraser, A. H. H., and Robertson, D.: Parasitic worms and their importance in sheep-farming. *Trans. High. and Agric. Soc., Scot.*, 1934.
12. Orr, J. B.: The National Food Supply and its influence on public health. Chadwick Lecture, 1934 (Reprinted).
13. Allcroft, W. M., and Godden, W.: Changes in the calcium and magnesium of the serum and in the inorganic phosphorus of the blood of cows at calving and of the calf during early life. *Biochem. J.*, **28**, 1004-1007, 1934.
14. Anderson, E. J. M., and Fraser, A. H. H.: The influence of nutrition on the natural immunity reactions of the blood and on skin reactions to bacterial toxins. *J. Immunol.*, **27**, 1-16, 1934.

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31. (CHEMICAL AND) ANIMAL NUTRITION DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

POULTRY.

Chicken rearing.—Further aspects were considered of the form of legweakness, preventable by liquid separated milk, mentioned in the report for last year. It was found that the incidence of this condition was much less severe when fish meal was the sole protein rich supplement than when the fish meal was partly replaced by soya bean meal or meat meal. The growth rate was reduced progressively as fish meal was replaced by meat meal and/or soya bean meal. The replacement of part of the fish meal by dried skim milk completely prevented the occurrence of the legweakness and led to more rapid growth. Dried yeast proved to be as valuable a supplement as dried skim milk. Soya bean meal when supplemented with dried skim milk did not give quite as good growth as fish meal supplemented with dried skim milk. A supplement of nine per cent. of soya bean meal to a ration of cereals and dried milk led to as good or better growth than higher levels of soya bean meal. In a similar experiment with equivalent amounts of fish meal in place of soya bean meal there were increases in growth with the use of the higher levels. The results of certain other experiments suggested that the factor concerned with preventing this legweakness may be a member of the Vitamin B complex.

Laying experiments.—In a further comparison of limestone grit with oyster shell grit no differences between the groups in terms of egg production or the health of the birds were seen.

In two duplicate experiments Sussex ground oats were replaced in the laying mash by extra bran, maize meal or by coarsely ground oats without any adverse effect on production or the health of the birds.

Good egg production was again produced by the use of rations containing large proportions of cooked potatoes but food consumption was doubled.

In four further experiments on the level of protein of laying rations, egg production was very slightly higher when 5 per cent. each of meat meal, fish meal and soya bean meal plus salt were used to supplement a cereal mixture than when salt was the only supplement, but in no experiment was the difference significant.

Mineral balance experiments.—A fourth experiment on mineral metabolism is being conducted at present. It is concerned chiefly with the verification of previous observations and their extension to include observations on certain alterations in nitrogen metabolism which appear to be correlated with the changes occurring in calcium and phosphorus metabolism with the onset of laying. Calcium and phosphorus metabolism is also being traced in pullets receiving a relatively high calcium carbonate intake (5 per cent. of the food intake).

Serum phosphatase studies.—Numerous observations have been made of the serum phosphatase activity of laying and non-laying pullets and of cockerels. The laying pullets usually show much higher values than cockerels or non-laying pullets but the values vary greatly from bird to bird. It has not been possible as yet, to conduct a sufficient number of observations on the factors governing the serum phosphatase values of laying birds; calcium deprivation appears to raise the value considerably.

Data have also been secured for normal white Wyandotte birds from day-old up to the onset of laying. There is a sharp rise to a maximum during the first two weeks, followed by an equally sharp fall to a lower value. Thereafter there is a gradual fall in both pullets and cockerels until the onset of laying. The fall continues in the cockerels; the pullets show large but variable increases in their serum phosphatase with the beginning of laying. Further experiments are in progress with a view to ascertaining the chief factors affecting the values in laying birds.

SILAGE.

The work on the comparative value of different methods of making grass silage has been continued. Unfortunately, the experimental wooden silos used in 1933 did not prove to be sufficiently air-tight and a considerable amount of the silage was spoiled by moulds. Sufficient good material was available, however, for digestibility trials with sheep and palatability trials with cattle. The silos were modified and have been used again for making silage by the four methods used previously namely, ordinary grass silage, molasses silage, and two methods involving the use of acids. The losses due to mould in this series were negligible and it is hoped to publish the results when the full data are available.

PIGS.

Nutritional anaemia.—An investigation of various methods of controlling anaemia in suckling pigs was undertaken and the progress of the various curative measures was traced by weekly determinations of the haemoglobin content of the blood of the young pigs. Very satisfactory results were obtained by smearing the teats of the nursing sow with a solution of iron sulphate, copper sulphate and treacle in water—a treatment suggested by American workers. In every case where this treatment was used the blood haemoglobin was found to be normal but the haemoglobin content of the blood of the control litters fell to one-fifth of the normal value and sometimes lower. The mortality among the control litters was very high, in one case amounting to 100 per cent., whilst that of the litters receiving treatment was normal. Litters ranging over pasture or kept confined but with a freshly cut sod placed in the pen daily, showed no signs of anaemia.

Rye middlings.—Large quantities of rye middlings have appeared on the market recently and three feeding trials have been carried out to investigate the use of rye middlings in rations for fattening pigs. A ration containing 40 per cent. of rye middlings caused very severe scouring in two separate groups of pigs. Pollards were substituted for the rye middlings in the ration of one group and the scouring ceased immediately. With another group of pigs a ration containing 20 per cent. of rye middlings was used. No scouring was observed and the growth rate was similar to that of another group of pigs fed on a similar ration in which wheat pollards was fed in place of the rye middlings. The fat of the carcases from both groups was satisfactory from the colour and firmness standpoint.

32. PIG HUSBANDRY RESEARCH STATIONS

(A) HARPER ADAMS AGRICULTURAL COLLEGE.

During the year three experiments were completed, the nature and results of which are briefly summarised below :—

(i) In a comparison of pure meat meal with commercial meat meal on the basis of equal protein supply, the specific superiority of the former that was found in a previous experiment (see last Annual Report) was not clearly confirmed. The general appearance of the pigs on the rations containing pure meat meal was better, but the difference in average live-weight gains between the lots, although pointing to the same conclusion, was too small to be regarded as significant. The fact that the pigs in the second experiment were older at the start has probably some bearing upon this apparent discrepancy.

(ii) In a similar comparison of pure whale meat meal with commercial meat meal, a marked difference in favour of the former was recorded. Final conclusions are deferred until the results of a second experiment now in progress are available.

(iii) In an experimental comparison no advantage was found from dividing the daily ration into three feeds as against two feeds. Food consumption and rate of growth was practically the same throughout for both lots.

Title of paper issued during the year.

1. Crowther, C., and Wright, T. S.: The work of the Harper Adams Pig Feeding Experimental Station, 1932-33. *Pig Breed. Ann.*, **14**, 171-180, 1934-35.

(B) SOUTH-EASTERN AGRICULTURAL COLLEGE, WYE.

The feeding and management of breeding stock.—The results of preliminary trials carried out during the year indicate that the addition of 2½ per cent. of dried blood to the ration of a nursing sow produced a clearly marked improvement in the growth of the pigs she was suckling, an even more clearly marked result was obtained from dried milk. The quantity used was 5 per cent. in the case of heavy eaters and 10 per cent. for sows with a small appetite. It has been found that the Large White and Saddleback (Essex) sows in the herd when on their full milking ration eat about 2 lb. per head per day less than the Large Black sows. Another difference observed is that Large White sows suckle their young at more frequent intervals than do the Saddleback or Large Black sows. There appears to be a danger of reducing the milk yield of Large White sows by keeping them away from the pigs they are suckling for more than an hour prior to the time the piglings are between 6 and 7 weeks old.

It has been found that normal growth can be obtained by using a mixture of cereal meals and minerals as the supplementary ration for sucking pigs. It was also observed in the preliminary trial that sucking pigs reared on this supplementary ration suffered less from scour than did those fed on the same mixture plus 12½ per cent. of foods rich in protein.

A heavier infestation of parasitic worms was found in litters which had been allowed out to graze than amongst those which were confined to styes.

Feeding experiments.—A series of trials were carried out designed to ascertain the economy of running growing pigs out of doors at different times of the year. The results indicate that the out-door pigs were less liable to digestive troubles than their indoor mates even during the winter months, but that providing these could be avoided the economy in meal consumption effected by allowing pigs out to graze was comparatively small. The damage done to the land by treading was sufficiently great to warrant the opinion that the system of keeping store pigs in small runs on grassland during the autumn and winter months is not practicable on the great majority of farms.

The use of a mixture consisting of 4 parts Epsom salts and 1 part nitre was found to reduce the incidence of digestive troubles amongst growing pigs confined to styes and thereby result in an economy in food.

Titles of papers issued during the year.

1. Fishwick, V. C.: The £ s. d. of bacon production. *Farmer and Stock-breeder*, 13th Nov., 1933.
2. ————: Pork or bacon production. *Ibid.*, 18th Dec., 1933.
3. ————: An out-door run for growing pigs. *Ibid.*, 8th June, 1934.
4. ————: Production to programme. *Ibid.*, 19th March, 1934.
5. ————: Stye feeding without setbacks. *Ibid.*, 24th Sept., 1934.
6. ————: Rearing young pigs. *Vet. J.*, March, 1934.
7. Annual Report. *J.S.E. Agric. Coll.*, 35, Jan., 1935.

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33. NATIONAL POULTRY INSTITUTE

(A) National Institute of Poultry Husbandry, Harper Adams Agricultural College.

Poultry and Egg Production.

Table chickens.—Fattening experiments showed that during the winter months chickens fattened on the run gave as good results as birds trough-fed in a fattening shed.

Fattening by four days of trough feeding and 10 days of cramming gave good results.

The results of feeding different percentages of weatings and maize meal were inconclusive and further experiments are in progress.

Experiments indicate that although the Wyandotte × Sussex cross produces a good type of chicken as regards shape and fineness of bone, its poor fertility may be a severe handicap to its use for table production.

An experiment conducted on the storage quality of battery-reared birds and normal-reared birds produced the following results :—

(i) Battery-reared birds to 14 weeks kept as well as normal-reared birds.

(ii) Bleeding of birds was essential for cold storage.

Egg quality.—Birds kept intensively and fed normal rations plus 10 per cent. dried grass gave pale coloured eggs.

Candling of eggs did not prove of any value as a criterion of the condition of the egg white.

Duck egg production.—Duck rations with soya bean meal plus salt gave as good an egg production as with supplements of fish meal.

Table duck production.—Supplements of soya bean meal plus salt did not give as good growth results as supplements of meat meal (60 per cent.).

Geese.—Goslings " grazed only " gave a normal rate of growth from 6 weeks to fattening.

Turkeys.—Rearing turkeys intensively gave good results and was effective in the control of " blackhead " ; but rearing extensively plus Neosalvarsan injections did not prevent high mortality from " blackhead."

Birds reared extensively gave a slower rate of growth.

STATISTICAL DEPARTMENT.

A statistical study was made of all experimental data carried out at the National Institute of Poultry Husbandry and at the Southern and Northern Stations of the N.P.I. Scheme.

A bulletin was prepared on Reaseheath experiments and has since been published.

The data obtained from the Harper Adams Laying Trials have been analysed and were reported at the Annual Poultry Conference, 1934.

Titles of papers issued during the year.

1. Table poultry production. *N.I.P.H. Bull.* No. 10, 1934.
2. Some features of the Harper Adams Agricultural College Laying Trials Records. *Rep.* 18*th H.A.A.C. Ann. Poult. Conf.*, 1934.

(B) REASEHEATH : CHESHIRE SCHOOL OF AGRICULTURE.

(NORTHERN BREEDING STATION.)

Work has been continued along the three lines of experiments of which a brief account was given in last year's report. These are (i) a cross breeding experiment to test the respective merits of cross breeding (i.e. first cross) v. pure breeding, (ii) a small scale experiment in which an attempt is being made to produce from one of the popular commercial breeds a strain of poultry capable of withstanding continuous in-breeding, and (iii) some preliminary experimental work to determine whether infertility in White Wyandottes is inherited or not.

The results so far obtained are being examined by the Statistician to the National Institute of Poultry Husbandry, but publication will not be possible for some years.

The report on the previous series of experiments extending over a period of eight years, in which a study of in-breeding was made using a father-daughter mating, has been published (1).

Title of paper issued during the year.

1. Dudley, F. J.: Experiments on inbreeding of poultry. *Bull.* 83, *Min. Agric.*, 1934.

(C) WYE: SOUTH-EASTERN AGRICULTURAL COLLEGE (SOUTHERN TABLE POULTRY SECTION).

Object of the experiments.

The main object of the experiments conducted in 1933 was to compare the gains in weight, the food consumption, the cost and the market returns of :—

(i) birds which did not undergo any fattening process;

(ii) birds which were trough fed throughout the fattening period;

(iii) birds which were trough fed during the first half and crammed during the second half of the fattening period; and to compare

(iv) the fattening of birds in their rearing quarters, in outside fattening crates and in the fattening shed.

Results of the experiments.

The following summary indicates the principal results obtained so far as these can be briefly described :—

(*a*) The percentage of birds lost in rearing was a good deal heavier among cockerels than among pullets, except during the period 14th February-30th May, when the losses among cockerels was 15·5 per cent. and among pullets 15·8 per cent.

(*b*) A period of trough feeding in the rearing quarters increased the weight of the birds, improved their texture and gave better market prices.

(*c*) In the majority of cases birds which were trough fed in their rearing quarters made slightly greater increases of weight than birds which were trough fed in the fattening shed, though these increases of weight were obtained at the cost of increased consumption of food.

(*d*) In cases where fat was added to the trough feeding mixture the resulting increase in weight was not more, on the whole, than in cases where no fat was added.

(*e*) The results obtained by trough feeding on the run followed by cramming in the shed were slightly better (about 8 per cent.) than the results obtained by trough feeding on the run followed by cramming in outside crates.

(*f*) The increased weights obtained when the whole of the fattening was done in the shed were better on the whole than when the birds were first trough fed in the open.

(*g*) Trough feeding and cramming in the shed gave results which on the whole were slightly better than those given by trough feeding and cramming in outside crates.

(*h*) The greatest gains were obtained in April and May, whilst the lowest gains were recorded in July and August, during hot weather, and again in November.

(*i*) There was a tendency for the cross breeds to gain more than the pure Light Sussex, especially during the second ten days. There was not a very great difference between the total gains of the two crosses used.

(*j*) Cockerels gained approximately 3·8 oz. more than pullets, on the average.

(*k*) The food consumption was greatest for the groups trough fed on the run, and least for the groups trough fed in the shed.

(*l*) *Market prices.*—These fluctuate from day to day. Comparable prices of birds produced by the many different methods of treatment used could not be obtained unless all the birds were marketed on the same day. It was, however, noticeable that, on occasions when unconditioned birds were marketed at the same time as birds which had been trough fed, the former did not make such good prices as the latter by 1d., and sometimes 2d. per lb. Crammed chickens nearly always made the best prices.

(*m*) *General conclusions.*—Trough feeding can be profitably undertaken in the rearing quarters, but when conditioning is to be finished by a term of cramming it is probable that slightly greater gains will be obtained by crating the birds in a building for trough feeding.

34. SMALL ANIMAL BREEDING RESEARCH STATION, CAMBRIDGE UNIVERSITY

As mentioned in previous reports the main work of the Institute is concerned with the possible existence of a sex-linked factor affecting fecundity. Gradual progress is being made with this complex matter. During the past few years a genetical analysis of egg colour has been in hand, having special relation to the blue shell. An account of this work has been published.

These experiments are being continued in view of the probable existence of linkage between the factors for blue shell and those for other characters. For ducks a dark race of Runners has been fixed, which can be used to give a sex-linked result. A similar race of Dark Campbells is in course of being established.

The work on rabbits is mainly concerned with the investigation of the genetical properties of certain forms of yellow which are at present difficult to understand.

35. INSTITUTE OF ANIMAL GENETICS, EDINBURGH UNIVERSITY

Genetics.

Plumage colour in the turkey.—A further stage in this study was begun, but since it is now quite impossible to obtain specimens of the Norfolk Black variety, it was necessary to manufacture them. This was done by breeding blue to blue since it had already been shown that blue can carry black. Out of this mating blacks have been secured, and these will be used for breeding with whites and buffs next year.

Specimens of the Narragansett variety, which is an American breed, but which was obtained here out of the cross white × buff, were bred together and further specimens reared.

Plumage colour in the goose.—Having learned that there was a small flock of buff-coloured, crested geese in the South of England for disposal, a number of them were purchased. The crest in the goose would seem to be, like the crest in the duck, a character that is not invariably expressed, for amongst their progeny only about 95 per cent. of the offspring exhibit this character.

Budgerigars.—Assistance was sought by budgerigar breeders, of whom there are many thousands in this country—indeed it can be said that there is a budgerigar breeding industry. In order to provide satisfying answers to the questions which were received from them and with the help of the breeders, an extensive breeding experiment was launched. As a result of this, a book on the genetics of the budgerigar has been written and will shortly appear. It was discovered that the budgerigar was indeed a most valuable material for genetic experimentation. Incidentally, a satisfactory explanation of what is known as the " half-sider " was found. The half-sider is a bird in which one side of the body exhibits the colour appropriate to one variety whilst the other side is of the colour characteristic of another variety, and there is a sharp line of demarcation between the two colours running from beak to tail tip. It was shown that this condition is the result of the loss of a chromosome carrying the dominant gene of the pair in a heterozygote; that, in every recorded instance, it is the same chromosome that has been lost, and in the majority of cases it is lost from that cell which gives rise to the right side of the body.

Canaries.—There are no less than 50,000 breeders of canaries in Great Britain, and in the course of their work they encounter many problems some of which can be appropriately investigated by the Institute. An experiment has been begun in which the genetic nature of the dominant and recessive whites, and of variegation will be examined.

Drosophila pseudo-obscura.—During the year this study has been continued and extended. Some 40 mutant characters have been investigated and their linkage relationships determined. It is to be expected that with the recent cytological advances in relation to the salivary glands of *Drosophila*, an extension of this work will yield results of very definite importance bearing upon the whole problem of species relationships.

Inheritance of educability in the rat.—This repetition of Professor William McDougall's tank experiment has been continued during the year and now it is becoming quite clear that Professor McDougall's conclusions cannot be sustained for the reason that the planning of his experiment and the form in which his results are presented must necessarily remove much strength from his arguments. However, the factors involved in this experiment are so many and are so complicated that if this repetition is to do more than merely cast doubt upon Professor McDougall's conclusions, the experiment must be continued until such time as the number and nature of these factors become revealed in the accumulated data.

AVIAN SEX PHYSIOLOGY.

Analysis of endocrine weights.—Data for some 400 individuals of each sex, from hatching to 18 months have now been collected and while the number of females in each group is fairly adequate, a number of extra birds could with advantage be included in some of the adult male classes, which throughout have been difficult to complete owing to the impossibility of keeping large numbers of cocks penned up together for sufficiently long periods.

Both the juvenile and the adult endocrine weights show interesting variations in relation to age and season. The most striking behaviour is that of the thymus. It has been held that this gland is purely associated with youth and degenerates in the mature animal. Actually the curves drawn from the collected data show that although it attains its maximum and begins to regress while the reproductive glands are still increasing in size, it has not entered into a permanent regression but recovers again at periods of gonad inactivity, such as occurs during the moult. Seasonal variations in the size of the thyroid and reproductive glands also occur at times of changing sexual activity, indicating that their weights reflect the functional changes of these glands.

In the case of the growing chick the time at which the different glands reach their maximum is available from this data and is of importance with regard to their relation to the onset of sexual maturity.

Variation of body weight with age.—Curves compiled from the fortnightly figures for body weight allow some interesting conclusions to be drawn: up to 16 weeks of age the body weight of normal males and females is practically identical. From this time onward there is an increased growth on the part of the male, both curves reaching a stationary level about 40 weeks. The onset of sexual maturity does not mean a cessation of the growth processes.

Perhaps the most interesting point emerging from this study is that, contrary to the general impression, the capon or castrated fowl, when raised on a normal diet, does not tend to be heavier than the normal male, at least up to 40 weeks of age. In fact for the greater part of this period the actual body weight is below that of normal males, due to an inhibition in growth following the operation for the removal of the sex glands.

Perforation of the oviduct.—In the young chick the posterior end of the oviduct is occluded by a thin membrane and presents no opening to the exterior. A study of the state of this membrane in growing pullets has brought to light the fact that its degeneration is under hormonic control and that its destruction is not caused by the laying of the first egg as might have been expected. The first indication of perforation appears as a tiny pin-point hole in the centre of the membrane some time before the hen is ready to commence laying. Later stages show the aperture enlarging and the membrane receding towards the walls of the oviduct. Some remnants of it often remain at maturity however and their final rupture at the shedding of the first egg is responsible for the frequent appearance of streaks of blood on the latter. This is a hitherto undiscovered secondary sexual character in the fowl.

Diagnosis of equine pregnancy by the capon test.—Since publishing a report of the technique and details of this method, the actual case histories of the majority of the mares tested for pregnancy have come to hand and the results in all cases agree with the diagnosis made by the capon test.

Hormone assays.—Tests and assays of sex hormone extracts and synthetic preparations have been continued in collaboration with Professor Dodds of the Middlesex Hospital. Urine from a few cases of "virilism" has been tested for the presence of sex hormones.

Oestrin standardisation.—The main portion of this rather detailed experiment concerning the response of the Brown Leghorn capon to oestrin has just been completed and the results are being analysed. During the past year four large scale standardisation tests have been made and it appears from these that a better response is elicited in aged than in immature birds by the same dosage. Seasonal differences are slight but individual differences between birds are very marked. The effects obtained in different birds vary widely, but poor reactors have remained poor throughout while good reactors have exhibited marked reactions in all the tests.

In the course of this study a new technique was devised by which it is possible to obtain a local reaction to the injection of minute doses of oestrin; the method involves the intradermal or subcutaneous injection of the hormone solution, which, if the dosage is sufficiently small, affects only the feathers in the immediate vicinity of the point of injection, the degree of effect waning according to the distance of the feathers from this point. The reactions obtained are of considerable interest in regard to the study of feather development since, in the transverse rows of breast feathers, the effect of the oestrin is greater on the side of the feathers nearest the row in which the hormone was administered.

Variation in number, size and shape of eggs with age and season.—In analysing the egg records collected the problem is being considered as to whether shape of egg can be used as a guide to the potentialities of the hen as a producer. In the first place it was necessary to determine the effect of season on egg shape and the relation, if any, between egg size and shape.

All yearly curves show that at the commencement of egg production the index for egg shape (length/breadth) is high and only reaches a minimum around the April-May period.

The index for shape is highest in the periods of low production and lowest in periods of high production, indicating clearly that a definite relation exists between average egg production and egg shape. That some relation also exists between weight and shape at the end of the laying season appears probable from the curves but this is complicated by the fact that this is also the period of rapidly falling egg production, so that the high index might on the other hand be due to a decrease in the size of the oviduct accompanying ovarian regression.

Individual records have still to be analysed to determine whether such a relation between production and index of egg shape may be used as a basis of selection for high egg production.

Genetical studies.—The genetical studies which were commenced last year (in an attempt to fix two characters of possible economic value—absence of moult and long continued persistency of production) are being continued. The problem of egg size is also being examined from the genetical standpoint and in this connection strains of large and small egg birds are being developed.

ANIMAL HUSBANDRY.

Owing to pressure of work in connection with the experimental farm, the statistical investigations into the inheritance of milking capacity in cattle have had to be suspended.

At the experimental farm of Shothead the work continues as outlined in previous reports. As yet, no attempt has been made to analyse the results obtained. It is felt that a premature analysis of results based on numbers not statistically significant might lead to false conceptions.

The first of the heifers born on the farm are now coming into milk. Cross-bred bulls between the beef and dairy strains of Shorthorn have now been obtained, and, except that the number of low yielding cows has been reduced, the work is proceeding according to plan.

Cockburn, the adjoining farm to Shothead, has been placed by the proprietors at the disposal of the Institute for the conduct of scientific investigations. A herd of pedigree Ayrshire cows is maintained. Since the rations and the system of management at Cockburn are essentially the same as at Shothead the records of the two places will be comparable. A pure-bred herd is maintained for the study of the inheritance of milk yield within a breed, and, as at Shothead, the milk of the individual cows is measured daily and analysed weekly. The stock now consists of some 63 cows and followers, making a total of over 100 cows available.

In the meantime an examination is being made of the practical worth of the Progeny Test. Groups of heifers sired by aged bulls have been purchased, and their records will be compared with those of their half-sisters in other herds and environments, and with the other groups by other sires under the same environment at Cockburn and Shothead.

It is intended to put all these Ayrshire cows at Cockburn to the one bull and to study the records of their daughters in order to determine the value which can be placed on the maternal grandsire. It will, of course, be about eight years before adequate figures will be available on this point.

The appointment of an additional Recorder in connection with the work at Cockburn enables the Cockburn records to be kept exactly as those at Shothead.

Pigs.—The work on pigs continues, so long as it does not involve a loss to the farm. Three years' records are now available for analysis when time permits.

Since the inauguration of the Pig Plant at Shothead, exact records have been kept of the weights of pigs marketed, and the prices received for them.

At the Institute a considerable amount of work has been accomplished on a review of the genetics of the pig.

Horses.—The stud of Shetland ponies has been retained, but, owing to the departure of Dr. Wiesner, it will be considerably reduced in the near future. The stud again furnished lactating mares to Professor Linton of the Royal (Dick) Veterinary College, who is making a study of the composition of mares' milk.

RABBIT BREEDING.

During the period under review the stock of Rex and other fur-bearing rabbits has been increased. This has been done by effecting a compensating reduction in the numbers of Angoras as it has been found that under the present scheme and with the present hutch accommodation the maximum number of stock it is possible to maintain is 300.

Following the line which has been suggested in previous reports a careful selection has been made of the Rex breeding stock. By this means the general vitality of the breed has been greatly improved, and it can now be claimed that a strain is being established which is every bit as hardy as the normal coated rabbit.

Fur texture has been the subject of study, particularly the mode of inheritance of the different types. It appears that fine fibres are dominant to coarse fibres, but the data relating to this will not be complete until at least two years more have been spent on their collection. It also seems that dense coat is dominant to thin coat, but as in the case of fine and coarse fibres it is probable that multiple factors are concerned rather than a single alternative pair.

In a few Rex rabbits at the Institute and elsewhere a new type of fur has appeared. Instead of being flat and plush-like, the coat is wavy. In the preliminary breeding experiments this character seems to be a recessive one. These wavy pelts promise to be of very considerable economic value and it is intended to analyse the mode of inheritance fully.

During the year problems relating to the period of moult have been receiving attention. No support has been found for the common belief that offspring are unsatisfactory moulters if bred from parents which were in moult at the time of mating. The rapidity of moult, however, seems to be definitely an inherited character, the offspring of rapidly moulting parents being also rapid moulters while slowly moulting parents beget slowly moulting offspring.

As in previous years records regarding reproduction are being kept. The data relate to all matters affecting duration of pregnancy, litter size, infertile coitus and sex ratio. Further data have also been collected which relate to the question of ideal litter size for both pelt and meat production.

The genetics of the three breeds, Smoke Pearl, Golden Glavcot and Hyracks, are being investigated and the production of new varieties by the recombination of already known characters is proceeding.

Reference was made in previous reports to two rabbits exhibiting somatic segregation which were presented to the Institute. A considerable F_2 and also F_1 back-crossed to P_1 has been bred from these rabbits but in no case has there been any indication that this condition is inherited.

SEX PHYSIOLOGY.

During the year the following studies were continued :—

(*a*) An hormonal investigation into the mechanism of parturition in the rat, in which the effects of oestrin alone and in conjunction with (i) the oxytocic principle of the posterior pituitary, (ii) secretion of the anterior pituitary, and (iii) substances from parturient rats were examined.

(*b*) A search for the possible existence of an internal uterine secretion, in which concentrated uterine extracts were tested on rats.

The inheritance of microphthalmia and associated abnormalities in rats was further investigated with special reference to chromosome constitution and skull formation.

The uterine state following cessation of luteal activity in the pseudo-pregnant rabbit or in the animal from which the foetal contents have been removed has been determined.

The alterations in the uterus of the mouse have been investigated and compared with those previously described for the rabbit, with special reference to the function of the ovarian hormones.

The action of oestrin in the pregnant mouse has been investigated with special reference to the causation of abortion in relation to the alterations occurring in the uterine muscle. Similar investigations for the pregnant rabbit have also been performed.

The action of the ovarian hormones on the muscle and endometrium of the hypophysectomised rabbit have been determined and the comparison of the results obtained in the intact animal and " in vitro " has been initiated.

An investigation of the action of oestrin in the lactating mouse has been performed with special reference to the quantitative relation between the action of the hormone and inhibition of mammary secretion.

An investigation of the excretion of oestrin in the human subject following the administration of known doses of the hormone has been performed.

The nature and significance of an oxytocic factor present in the blood of some animals have been investigated.

SHEEP.

Inheritance of kemp in Blackface.—The observations on the inheritance of kemp in Blackfaces which have been in progress for the past three years have now been completed. A paper dealing with the results of these studies has now been submitted for publication.

Foetal birth coat development.—Considerable progress has been made with a collection of accurately dated Blackface foetuses illustrating the development of the birth coat.

Experiments with Cheviot wool.—Further experiments destined to throw more light upon the influence of inheritance as distinct from environment on Cheviot wool were tentatively arranged. These involved, in the first place, a reciprocal transfer of a small number of accurately sampled ewes between Sutherlandshire and Roxburghshire, and the rearing of a small flock of lambs from each. It was proposed that the wool grown during their stay in this " foreign " environment should be carefully analysed, and that they should then each return to their original farms and be sampled again. Meantime the lambs born from each were to be reared where they were born and careful notes made of the type of wool grown. Controls were in each instance to be kept. Unfortunately these experiments had to be abandoned.

The crossing of rams extracted from Merino blood on to Cheviot ewes, with a view to increasing fibre population density and fineness, was continued. Manufacturers to whom many samples of this wool were sent, expressed very encouraging views of its commercial possibilities.

Inheritance of colour.—Further work on the mode of inheritance of colour was carried out. By arrangement it was found possible to leave in the Institute certain pregnant ewes which had been mated up in Autumn, 1934, to lamb in April-May, 1935. Several visits have been paid to Edinburgh to supervise these sheep, and it is hoped to get data from them which will complete a survey of colour inheritance which has been in progress for five years.

Inherited deformities in sheep.—Information was collected from the 1934 lambings concerning the inheritance of physical deformities. It was found that there was strong evidence to support the preliminary conclusions arrived at in previous years that the conditions " hog-mouth " (in which the lower jaw is shorter than the upper), hare-lip, cleft-palate, and hernia in males, each behave as simple Mendelian recessives in inheritance.

Titles of papers issued during the year.

1. Bryant, D. M.: A note on the inheritance of kemp in Blackface sheep. *J. Text. Inst.*, **24**, T309-T316, 1933.
2. Bryden, Wm.: The relation of age to the frequency of chiasma formation in the Wistar rat. *J. Genet.*, **27**, 415-420, 1933.
3. ———: A comparison of the chromosomes of the rat and the mouse. *Ibid.*, **27**, 421-433, 1933.
4. ———: The effect of sex on the frequency of chiasma formation and its relation to crossing over in the Wistar rat. *Cytologia*, **4**, 241-247, 1933.
5. ———: The chromosomes of the pig. *Ibid.*, **5**, 149-153, 1933.
6. Grant, R.: Occurrence of ovulation without " heat " in the ewe. *Nature*, **131**, 802, 1933.
7. ———: The pigmentation of the uterine mucosa in the ewe. *Vet. J.*, **89**, 6, 271-274, 1933.

8. Marshall, P. G.: The gonadotropic hormones (p-factors). V. The effect of large doses on subsequent fertility. *Brit. J. Exp. Path.*, **14**, 246-250, 1933.

9. Robson, J. M., and Taylor, H.: Factors influencing the functional development of the male gonad. *Proc. Roy. Soc. B.*, **113**, 251-267, 1933.

10. Smith, A. D. Buchanan, and Robison, O. J.: Heredity in pigs. *Vet. J.*, **90**, 3, 119-127, 1933.

11. Smith, A. D. Buchanan: Inheritance of milk yield. *Brit. Goat Soc. Yr. Bk.*, 1933.

12. Wiesner, B. P.: Bemerkung über die Wirkung von "Proviron" auf den Penis und die Klitoris der Ratte. *Klin. Wschr.*, **12**, 1813, 1933.

13. Crew, F. A. E.: Biology applied to human problems. *Scott. Educ. J.*, **17**, 43, 1338-1339, 1934.

14. ————: Sex: its nature and abnormalities considered from biological and legal points of view. *Proc. Roy. Soc. Med. Sec. Obstet., Gynaecol. & Med.* Oct., 1934.

15. Crew, F. A. E., and Lamy, R.: The second linkage group in *Drosophila pseudo-obscura*. *J. Genet.*, **29**, 2, 269-276, 1934.

16. Grant, R.: Studies on the physiology of reproduction in the ewe. I. The symptoms, periodicity, and duration of oestrus. II. Changes in the vagina and cervix. III. Gross changes in the ovaries. *Trans. Roy. Soc. Edin.*, **58**, 1, 1-47, 1934.

17. Greenwood, A. W., and Blyth, J. S. S.: Biological methods of diagnosing equine pregnancy. Pt. 2. The capon test. *Proc. Roy. Soc. B.*, **116**, 247-258, 1934.

18. Cooke, J. W., Dodds, E. C., and Greenwood, A. W.: Sex change in the plumage of Brown Leghorn capons following the injection of certain synthetic oestrus-producing compounds. *Ibid.*, **116**, 286-290, 1934.

19. Hain, A. M.: The physiology of pregnancy in the rat. Further data bearing on the prolongation of pregnancy, with a study of the effects of oöphorectomy during pregnancy. *Quart. J. Exp. Phys.*, **24**, 101-116, 1934.

20. ————: Effect upon lactation of oöphorectomy during pregnancy (albino rat). *Quart. J. Exp. Phys.*, **24**, 117-121, 1934.

21. ————: Some facts regarding the growth of the Wistar rat under standard conditions in Britain (derivative Edinburgh stock). *Anat. Rec.*, **59**, 3, 283-391, 1934.

22. ————: The effect of suckling on the duration of pregnancy in the rat (Wistar albino). *J. Exp. Biol.*, **11**, 3, 279-282, 1934.

23. Koller, P. Ch.: Spermatogenesis in *Drosophila pseudo-obscura* Frolowa. II. The cytological basis of sterility in hybrid males of races A and B. *Proc. Roy. Soc. Edin.*, **54**, 1, No. 7, 67-87, 1934.

24. Koller, P. Ch., and Darlington, C. D.: The genetical and mechanical properties of the sex-chromosomes. I. Rattus Norvegicus, ♂. *J. Genet.*, **29**, 2, 159-173, 1934.

25. Marshall, P. G.: Recent experimental work on the gonadotropic hormones. *Glasgow Med. J.*, 117, June, 1934.

26. Robson, J. M.: Pregnancy diagnosis in theory and practice. *Brit. Med. J.*, 1063, 16th June, 1934.

27. ————: The significance of the luteal action on the uterine muscle in the maintenance of gestation and initiaton of parturition. *J. Phys.*, **81**, 3, 372-381, 1934.

28. Robson, J. M.: Uterine reactivity and activity in the mouse at various stages of the sex cycle. *Ibid.*, **82,** 1, 105, 1934.
29. ————: Recent advances in sex and reproductive physiology. J. & A. Churchill, 1934.
30. Robson, J. M., Macgregor, T. N., Illingworth, R. E., and Steere, N.: Urinary excretion of oestrin administered under experimental conditions and after the menopause. *Brit. Med. J.*, 19th May, 1934.
31. Smith, A. D. Buchanan.: The show standards of cattle. *J. Min. Agric.*, **41,** 7, 623-631, 1934.
32. Pickard, J. N.: Fur production and the rabbit fur farmer. *Harper Adams Utility Poult. J.*, **17,** 481-483, 1933.

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36. (CROP AND) ANIMAL HUSBANDRY DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

Erection of piggeries, etc.—The piggeries at the Agricultural Research Institute farm, which were completed in 1933, have been the object of great interest to farmers and other visitors. The general layout of the buildings and the successful incorporation of new ideas in the construction of the interior of the pig houses have been of great assistance to Northern Ireland pig producers in the erection of piggeries on their own farms. Full particulars of the design, with sketch plans, construction and cost of the piggeries have been published (1).

Pig recording is being carried out on a comprehensive scale with a view to building up a first class breeding herd of Large Whites. Several experiments in pig nutrition are in progress. A new fattening house is being built by direct labour on the farm. This house will be available for nutritional experiments and will incorporate, *inter alia*, individual feeding troughs to fulfil requirements for modern experimental technique.

Sheep breeding.—An experiment has been commenced to compare certain crosses for the production of butchers' lamb. It has been decided to confine the crosses to existing breeds in Northern Ireland, and during the period of the experiment it is hoped to collect data on the relative merits of the crosses in the production of early lamb and also to ascertain the most suitable cross for wintering.

Title of paper issued during the year.

1. Rae, R.: Piggeries at the Agricultural Research Institute for Northern Ireland. *J. Min. Agric.*, **41,** 3, 229-239, 1934.

DAIRYING

37. NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING

HUSBANDRY.

Inheritance of milking performance.—The information collected during the development of the Institute's Dairy Shorthorn herd from 1920 to 1933 has been carefully examined with special reference to the methods which can be used to assess the value of dairy bulls from the milking performance of their daughters. A report has been completed during the year and published (10). A study is also being made of the progeny records of bulls used in later years, both Shorthorn and Guernsey.

Feeding of dairy cattle.—Yearlings were wintered both indoors and outdoors on rations designed to compare the relative efficiency for growth of fish meal and chalk when fed in quantities of approximately equivalent mineral content. Both indoors and outdoors the fish meal ration was more satisfactory.

A request having been made that the Institute should consider a new process of sprouting seeds to produce a fodder for cattle, the necessary equipment was installed and three separate feeding trials, using in each case lactating cows, were carried out. The results showed that sprouted maize was a satisfactory food for dairy cows, but that there was nothing to indicate that its feeding value was superior to other good farm foods supplying an equal amount of nutrients. A full account of the process, the apparatus and the experiments, together with a short chemical study of the sprouted maize has been published (47).

Causes of removal of cows from dairy herds.—This investigation, which commenced in October, 1929, has now been completed and the question of the publication of a report is under consideration.

Milking machine investigations.—The Institute's records of the results of machine and hand milking over a period of eight years have been analysed. As measured by milk yield and persistence of secretion the advantage of hand-milking over properly-conducted machine milking is small. Observations on the relative efficiency of the two methods will be published shortly.

Feeding of pigs.—Using 8 pens of 41 young pigs in all it has been found that 5 per cent. of dried milk in a good meal mixture increases the rate of growth in lb. per day by some 18-20 per cent., whilst 20 per cent. of dried milk increases the rate by over 30 per cent. The 20 per cent. addition was, however, grossly uneconomic, whereas the 5 per cent. addition, taking all the factors into account, might have yielded a profitable return if the dried milk could have been bought at less than 32s. per cwt. (See also paragraph "Vitamin A in pig feeding" on page 178.)

A proprietary wheat germ preparation was tested for its effect on the growth of pigs when included in the rations from 4 weeks old until the animals were sent to the factory for bacon. At 5 per cent. level (but not at 2½ per cent.) there was increased growth, but it was concluded that for fattening pigs the preparation tested showed no advantage over a similar proportion of weatings.

Anaemia in suckling pigs.—Methods for preventing this condition in young pigs have been tested at the Institute. Two methods which appear to give results are (i) allowing the young pigs access to cinders impregnated with commercial ferrous sulphate solution, and (ii) rubbing a ferrous sulphate solution on the teats of the sow daily from one week after farrowing until the young pigs take solid food (4).

HUSBANDRY AND CHEMISTRY.

A study of typical English milk.—The experimental part of this investigation, which began in 1928, was concluded in September, 1933. The general results have since been summarised and are now in the press. New and interesting relationships have been observed in the last year of the experiment, particularly during the drought period of 1933. A clear correlation between the non-fatty-solid content and the phosphorus content of the milk may be mentioned as an example. Further statistical examination of the data is contemplated. The nitrogen distribution in the milk has been shown to be very uniform. This uniformity may supply a much needed addition to the very small number of criteria of normality in milk. No significant variation, seasonal or otherwise, has been found in the copper or iron content of this typical, normal milk.

During 1932 and 1933 the vitamin content was studied during winter, summer and autumn periods, and a report is in course of preparation.

Solids-not-fat content of milk.—The analysis of the records collected from the Institute herd during ten years has been continued, and two papers dealing with the variation in the solids-not-fat content of milk during a lactation period and the influence of age and pregnancy on it have been published (1).

An endeavour is being made to disentangle the factors responsible for the low quality milk which is sometimes produced during the summer period. (This is alluded to in a subsequent paragraph under heading "Milk of individual cows.")

CHEMISTRY.

Methods.—Careful re-examination of certain methods and apparatus used in dairy laboratories has been carried out during the year, mainly for the committee established by the Empire Marketing Board (now working under the auspices of the British Standards Institution). Part of this work has been published (19, 20, 21).

Milk of individual cows.—The chloride content of milk of individual cows has been further investigated. There is little doubt that chloride provides another index of chemical quality of milk, a high chloride content being almost always associated with low quality milk. This has been shown to be true of the " physiological " fall in milk quality which was quite marked during the 1934 drought period. Two groups of similar cows were maintained during this period, one indoors and the other out day and night. Whereas there was a marked fall in the non-fatty solids of the outdoor group despite additional feeding, the group kept indoors did not give milk low in these constituents. The causes, associated with drought conditions, which influence milk composition are being further investigated in collaboration with the Husbandry Department.

Abnormal milk.—A test for use in the cowshed has been developed which combines the strip-cup test with the brom-cresol purple test, thus permitting of the detection of mastitis by a single examination whether the disease is in the " alkaline " or the " acid " stage. The protein distribution in normal and abnormal milks has been further studied.

Molassed beet pulp (taint in milk) enquiry.—Considerable progress has been made during the year under review. The presence of trimethylamine and trimethylamine oxide has been shown in samples of " fishy " milk which have been obtained from various herds outside the Institute, fed on beet products. Metabolism experiments have indicated that trimethylamine oxide is the main (tertiary) nitrogenous metabolite of betaine and choline when fed to the cow. The oxide is regarded as the precursor of the actual taint. Whether or not the taint develops appears to depend in the main on conditions in the udder. Normal cows appear to excrete less trimethylamine and trimethylamine oxide than cows with diseased or abnormal udders. Udder bacteria are also capable of reducing the oxide in milk to trimethylamine.

Calcium content of cows' blood.—The results of work done in collaboration with Capt. W. L. Little, F.R.C.V.S., on calcium in the blood of parturient heifers, on the effects of injection of parathyroid extract on blood calcium and on the blood calcium in some cases of milk fever have been published (48).

Lipase in milk.—The enzymic characteristics, physiological relationships and significance in dairying of the lipase of milk are being investigated.

Phosphatase in milk and in butter.—Earlier results have been published (37, 38). The test for phosphatase in milk and butter has been rendered much more delicate and more simple in operation. It is now possible, using a modified phosphatase test to decide with certainty and within a few minutes whether a milk has or has not been pasteurised, and by an extension of the test to 24 hours, to detect even small errors in pasteurisation technique.

Nutritive value of raw and heated milk.—A lengthy series of bone analyses has been completed and it is hoped to publish the final results shortly.

Effect of feeding on the fat of milk.—The lowering of the percentage of fat in the milk of cows fed cod-liver-oil also occurs when sardine oil is fed. Rape and linseed oils appear to have no such effect. The depression appears to be due to the fatty acids of the cod-liver-oil, and not to non-saponifiable constituents. A study of the ultra-violet absorption of the fatty acid fractions of the various oils fed during this experiment has led to the discovery that a similar effect in increasing the ultra-violet absorption of the fatty acids of several different oils is obtained, by the ordinary processes of metabolism and butter fat formation on the one hand, and by prolonged boiling with caustic potash on the other. This change would appear to provide a valuable weapon in the study of the changes in alimentary fat in the cow, and in problems of fat metabolism and secretion generally, and this is now being used.

Vitamin A in pig feeding.—The great importance of an adequate supply of vitamin A for the health of young pigs has been strikingly demonstrated during the year. Characteristic symptoms of paralysis, occurring in young pigs fed a diet which would be accepted as satisfactory by most pig husbandrymen, have been cured or prevented by the feeding of vitamin A concentrates, of cod-liver-oil, or of home-dried full-cream milk. These findings agree generally with those recently obtained independently in Cambridge. The two investigations provide a valuable supplement for each other.

The antirachitic activity of butter.—The fatty acid fraction of saponified butter carried with it an appreciable part of the "vitamin D" activity of the original butter. Mixed glycerides resynthesised from these fatty acids also possess antirachitic power. These results have been confirmed and extended by careful metabolic experiments (25, 26, 27).

Seasonal variations in the vitamins, etc., of butter fat.—A pronounced seasonal variation in the absorption of light of wavelength 230 $m\mu$ by the fatty acids of butter has been observed, and is being examined in collaboration with the Cambridge Nutritional Laboratory (23).

Comparison of vitamin A activities of Shorthorn and Guernsey butter.—This work has been extended to cover winter, summer and autumn butters (24). Under identical conditions of feeding and management no difference in the total vitamin A activity was found by biological test, although the Guernsey butter was invariably much yellower than the Shorthorn butter, owing to the larger carotene content of the former. In joint work with the University of Manchester, the carotene and vitamin A contents of the butters were measured spectrophotometrically, and it was found possible to assess the relative activities of equal weights of carotene and vitamin A. The vitamin A of butter is about six times as potent, weight for weight, as carotene.

Vitamin C in milk.—Further work is in progress on the effect of light on vitamin C in milk.

Food wrapping materials.—Work on the effect of the wrapping material on the fat of fatty foods has been published (14). Further work is being carried out on moisture-loss through various wrappers. Papers such as hard neutral vegetable parchment with a high wet strength are valuable in preventing moisture losses from fatty foods.

Whey silage.—A paper on the use of whey in silage making has been published (22).

BACTERIOLOGY AND CHEMISTRY.

Cheese ripening studies.—Further progress has been made along lines indicated in the 1933 report. Some of the earlier work has been published (29).

In collaboration with the experimental dairy, a number of experimental cheese have been made, in which various added substances have been incorporated with a view to (*a*) changing the pH of the ripening cheese, (*b*) altering its normal oxidation-reduction potential, (*c*) inhibiting lactic acid-fermentation, (*d*) changing the normal salt equilibrium in the cheese. The experiments are not yet completed.

The rôle of rennet in cheese ripening has been investigated. There are probably at least four proteinases present with different pH optima for activity; " pepsin " (optimum about pH$_2$); a papainase (optimum pH 4·7); a tryptase (sharp optimum pH 6), and a rennin (sharp optimum pH 6·2). The last two enzymes may be identical (29).

BACTERIOLOGY.

The lactic acid bacteria.—A systematic study of the true lactic acid bacteria is in progress, using the newer metabolic methods (30). A Barcroft-Warburg apparatus is being used for this purpose. A micro method has been worked out for the estimation of acetoin and diacetyl.

Red spot.—As a result of previous work it was suggested that the "red spot" organism is saprophytic in the udders of cows suffering from mastitis. This has received further support from the examination of single cow samples from the herds of infected farms. Whether or not the elimination of cows whose milk contains the red spot organism would prevent the subsequent appearance of red spot in cheese made on an infected farm remains to be demonstrated.

Stilton cheese.—Studies on the factors influencing ripening of Stilton cheese have recently been restarted. The way in which the atmosphere within and without the cheese can be correlated with the development of "blueing" is under investigation. Pricking will usually ensure blueing, but the stage at which the pricking is done is of first importance if a mature cheese is to result. A method is being sought which will allow of the examination of the development of the blue colour within the cheese without boring. X-ray photography has so far met with limited success.

Spore-bearing bacteria in milk.—In market milk the presence of spores has been shown to be unexpectedly rare, even with milk produced under poor conditions. Appreciable numbers were found only during the winter and early spring. Many samples, however, contain vegetative forms of spore-bearing bacteria. Under normal conditions aerobic spore-bearers do not regenerate spores in milk culture, but in diluted milk (1/100) or sterile tap water in contact with metal surfaces sporulation of certain of these organisms has been observed.

Factors influencing the numbers of organisms surviving heat treatment.—The conditions of production of milk are known to determine to some extent the numbers of organisms which survive pasteurisation. It has been found that relatively small differences in the reaction of the milk before pasteurisation have an important effect, the higher the acidity, the greater the proportion of organisms destroyed at the same pasteurisation temperature.

The Vernes test as applied to bovine tuberculosis.—It has not been possible to obtain any useful information by this method (used either in its original or in a modified form), for distinguishing between normal and known tubercular bovine sera (33).

Viability of bovine tubercle bacilli.—In an endeavour to secure data as to the management of pasture which has been grazed by infected stock, two series of experiments have been carried out. (*a*) With grass artificially infected four times with virulent tubercle bacilli, a high incidence of infection was obtained, either with calves or guinea-pigs; (*b*) with grass infected by calves passing tubercle bacilli in the faeces (after the animals had been given emulsions of virulent bovine tubercle organisms by mouth). Fresh tuberculin-tested calves were fed on the grass five weeks, nine weeks and fourteen weeks after infection of the pasture. So far, no evidence of infection of the calves has been obtained.

Brucellar abortion in the Institute herd.—The herd became infected with brucellar abortion about twelve months ago, and every effort is being made to eradicate this disease. During the year all cows have been tested monthly (at the Institute) by the agglutination reaction, and the opportunity has been taken to obtain first hand information as to the value of this test. A few curious and rather disturbing anomalies have been demonstrated. A number of samples of whey from individual milks have shown that in no case did a cow with a negatively reacting blood serum give a positive whey titre.

High temperature-short time pasteurisation.—The work done last year on this subject has been rounded off by further trials under commercial conditions. Some of the findings have been published (34).

PHYSIOLOGY.

Solids-not-fat to fat ratio.—A paper on this work has been published (46). The investigation has been extended to include other breeds beside the Shorthorn, and it has been confirmed that the divergent ratios of solids-not-fat to fat observed in the milks of different breeds are associated with parallel differences in the sodium to diffusible calcium ratios of their bloods.

Secretion of milk proteins.—Purified specimens of the principal proteins of blood and of milk have been prepared and are ready for the next stage of this investigation.

Secretion of other milk constituents.—The rate of elimination of urea in the milk has been studied. This study has included in the first instance the elaboration of a method for urea determination applicable to a number of samples at one time.

Variations in blood composition.—Since the variations in composition between blood entering and blood leaving the mammary gland are small, it is of importance to determine the changes occurring in the composition of blood over short periods of time, apart from changes in the mammary gland. It has been shown that changes occur within short periods of time, even from minute to minute, which are outside the limits of analytical error, and which may be accentuated by some procedures that are not infrequently used in taking blood samples from the cow. A preliminary note has been published (45). Further publication will be made shortly.

Methods.—The method of making collodion membranes for low pressure ultra filtration has been improved (43). A small electric heater for micro Kjeldahl digestion and similar purposes has been devised (44).

Titles of papers issued during the year.

1. Bartlett, S.: Variations in the solids-not-fat content of milk, I and II. *J. Dairy Res.*, 5, 113-123, 1934.
2. ———: Poor quality milk. Variations in the solids-not-fat content. *Berks. Farmers Yr. Bk.*, 45-58, 1934.

3. Bartlett, S. et al.: Records of type, size and production of representative animals at the London Dairy Show 1933. *J. Brit. Dairy Farmers' Assoc.*, **46**, 89-108, 1934.
4. Foot, A. S.: Anaemia in suckling pigs. *Pig. Breed. Gaz.*, **28**, 89, 1934.
5. Mackintosh, J.: Sprouted Maize in cow feeding. *Farmer and Stockbreeder*, 2337, 1687, 1934.
6. ———: Quality in milk and milk products. *Ibid.*, 2323, 916, 1934.
7. ———: Dairy farming and dairy work. *J. Roy. Agric. Soc. Eng.*, **94**, 194-221, 1934.
8. ———: The beginning of milk recording in Berkshire. *Berks. Milk Recording Soc. Yr. Bk.*, **52**, 1932-33.
9. ———: The accredited producers register. *Jersey Cow*, **14**, 6-8, 1934.
10. ———: The progeny testing of dairy bulls. *J. Brit. Dairy Farmers' Assoc.*, **46**, 11-31, 1934.
11. Davies, W. L.: Diacetyl in butter. *Food Manufacture*, **8**, 346-348, 1933.
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13. ———: The metabolism of betaine in the ruminant. The fishy flavour of milk on feeding beet by-products. *J. Soc. Chem. Ind.*, **53**, 178. 1934.
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16. ———: Chemical control in the manufacture of condensed milk. *Food Processing*, **3**, 290-292, 335-338, 1934.
17. ———: The deterioration of sodium hypochlorite solutions. *Analyst*, **59**, 619-620, 1934.
18. ———: The whipping of cream. *Food Processing*, **3**, 85-86, 1933.
19. Golding, J.: Milk tests. *Agric. Prog.*, **11**, 115-119, 1934.
20. ———: The use of the air-damped balance for the determination of total solids in milk. *Analyst*, **59**, 468-474, 1934.
21. ———: Progress in milk testing. *Proc. 10th World's Dairy Cong.*, Part IV, 57-60, 1934.
22. ———: A new use for surplus whey - whey silage. *Ibid.*, Sect. I. 9-13, 1934.
23. Booth, R. G., Kon, S. K., et al.: A study of seasonal variation in butterfat. I. Seasonal variations in carotene, vitamin A and the antimony trichloride reaction. *Biochem. J.*, **27**, 1189-1196, 1933.
24. Kon, S. K. and Booth, R. G.: The colour and vitamin A activity of butter as affected by the breed of the cow. *J. Soc. Chem. Ind.*, **52**, 844, 1933.
25. ———: The vitamin D activity of butter. I. A chemical differentiation of the antirachitic factor of autumn and winter butter from irradiated ergosterol and the vitamin D of cod liver oil. *Biochem. J.*, **27**, 1302-1309, 1933.
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27. ———: The vitamin D activity of butter. III. An attempt to elucidate the nature of the labile factor in butter antirachitic for the rat. The antirachitic potency of lard, olive oil, egg oil and the fatty acid of butters and lard. *Ibid.*, **28**, 121-130, 1934.
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31. McClemont, J.: Yoghurt. *Food Manufacture*, **9**, 49-50, 1934.
32. Mattick, A. T. R.: Destruction of bacteria in milk by ultra-violet light. *Milk Industry*, **14**, 34-36, 1934.
33. Mattick, A. T. R. and Christian M. I.: The Vernes test for the diagnosis of tuberculosis in dairy cattle. *J. Hygiene*, **34**, 157-165, 1934.
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35. ———: An illuminated counting chamber for plate cultures. *J. Sci. Instruments*, **10**, 373-376, 1933.
36. Graham, W. R.: The effect of thyroxine on the milk and milk fat production of normal cows. *J. Soc. Chem. Ind.*, **53**, 453, 1934.
37. Graham, W. R., and Kay, H. D.: Phosphorus compounds of milk. V. The phosphorus partition in milk, with preliminary observations on milk phosphatase. *J. Dairy Res.*, **5**, 54-62, 1933.
38. ———: Phosphorus compounds of milk. VI. The effect of heat on milk. Phosphatase. A simple method for distinguishing raw from pasteurised milk, raw from pasteurised cream, and butter made from raw cream from that made from pasteurised cream. *Ibid.*, **5**, 63-74, 1933.
39. ———: Phosphatase and the phosphorus compounds of milk. *Agric. Prog.*, **11**, 119-121, 1934.
40. Kay, H. D.: The chemistry and metabolism of the compounds of phosphorus. *Ann. Rev. Biochem.*, **3**, 135-150, 1934.
41. ———: The improvement of the nation's milk supply. *J. Soc. Chem. Ind.*, **52**, 363-367 T, 1933.
42. Kay, H. D., Simpson, S. L., and Riddoch, G.: Osteitis Deformans, *Arch. Int. Med.*, **53**, 208-248, 1934.
43. Folley, S. J.: Standardised Collodion membranes in low pressure ultra-filtration. *Biochem. J.*, **27**, 1775-1778, 1933.
44. ———: An electric furnace for micro-kjeldahl digestions and similar purposes. *Ibid.*, **28**, 890-891, 1934.
45. Folley, S. J., and Peskett, G. L.: Blood composition in relation to milk secretion. *Nature*, **133**, 142, 1934.
46. Peskett, G. L.: The effect of salts on cell permeability as shown by studies on milk secretion. *Proc. Roy. Soc. B.*, **114**, 167-180, 1933.
47. The Spangenberg process of sprouting maize for fodder, N.I.R.D., Shinfield, June, 1934.
48. Little, W. L., and Mattick, E. C. V.: The calcium content of cows' blood. II. (*a*) Calcium in the blood of parturient heifers; (*b*) Effect of injections of parathyroid extract irradiation, etc.; (*c*) Some case reports of milk fever. *Vet. Rec.*, **13**, 1091-1097, 1933.

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38. HANNAH DAIRY RESEARCH INSTITUTE

Nutrition.—Investigations into the relation between the amino-acid content and the nutritive value of proteins for milk production have been continued. The amino-acid contents of a number of foodstuffs in common use have been determined and the results published (1). Practical applications of the whole investigation have been summarised in a recent publication (2).

This work has now been extended to include a study of the nutritive value of the proteins of fresh spring and autumn grass, and of grass conserved by ensiling—with and without the addition of acid. Preliminary results indicate the superiority of spring over autumn grass as a source of protein for milk production, while grass silage was found to give fairly uniformly satisfactory results. The details of this work will be published shortly.

Reproduction.—In the last report reference was made to the importance of the pituitary gland in relation to parturition. A method has now been devised for estimating the oxytocic property of the blood (3). This method has been applied to pregnant cows and to cows immediately before and after calving. It has been found that the level of the oxytocic substance in the blood increases immediately before calving, but that with normal animals this increase is only temporary. With cows affected with milk fever, however, the increase persists for some considerable time (4).

Lactation.—The investigation of the mode of secretion of fat and of phosphorus compounds in milk has been continued. It has been shown that the conclusions reached by previous workers on this subject were erroneous, owing to the differences which are found between the composition of arterial and venous blood (5). A new method is now being employed in the investigation of this problem.

In addition to the above work a study has been made of the action of digestive enzymes on lecitho-vitellin, a phospho-protein somewhat similar in properties to casein. The results of this study have been published (6).

Genetics of dairy cattle.—Work on the genetic construction of the Ayrshire breed of dairy cattle is being continued. In view of the existence of certain complicating factors, it seemed desirable, however, to extend considerably the scope of the work, and in particular to examine the breeding methods practised by owners of vessel- and milk-bred stock respectively. Such work is extremely laborious. In tracing each pedigree to the sixth generation 126 ancestors are involved, and some indication of the scope of the work can be realised when it is stated that the investigation entails the checking and recording of over 240,000 entries. It is hoped that the investigation will be completed during the forthcoming year.

Grass conservation.—During the past three years an investigation has been made into the yields of closely cut growing herbage obtained under the favourable climatic conditions of the south-west of Scotland. The results indicate that remarkably high yields of grass can be obtained by suitable manuring. There is, however, some indication that the continued use of artificial fertiliser is gradually resulting in a decreased yield per acre. The investigation is therefore being continued for a further year.

The primary object of this work was to ascertain whether the conservation of young grass by artificial drying could be placed on an economic basis. In this connection a study has also been made of the relation of the moisture content of artificially dried grass to its keeping quality. Samples of dried grass have been stored in atmospheres of widely differing humidities and the keeping quality has been observed. While the investigation is not yet completed, it appears that the optimum moisture content for storage will fall between 11 and 13 per cent.

Technical research.—Investigations into the factors affecting the solubility of milk powders and into the conditions governing the heat coagulation of milk proteins have been continued. A careful study has been made of the physico-chemical properties of highly concentrated solutions of milk solids. The results (7) show that increasing concentration is accompanied by a marked increase in acidity, with a consequent reduction in the stability of the proteins. The osmotic properties of the solutions show no appreciable deviation from the expected values.

Side by side with this work the effect of heat in causing a cleavage of phosphorus from the casein molecule has been investigated. It has been shown (8) that the cleavage of phosphorus has been accompanied by a marked reduction in the stability of the casein. The possible application of this finding to the heat coagulation which occurs in evaporated milk is being studied.

In addition to the above work, two other technical problems are being studied at the Institute. In the first place an investigation is being undertaken into the nature of the bacterial defects which occur in canned milk products. The main defects reported are gas formation (" blowing ") in evaporated milk and bitterness in canned cream. Examination of defective products has revealed the presence of various contaminating organisms. These are being typed and their thermal death-points determined.

In the second place a survey has been made of the pasteurising plants in the four Scottish cities, with the object of determining the major faults in their construction and operation and of suggesting means by which improvements could be effected. It is hoped that the results of this survey will be published shortly.

Titles of papers issued during the year.

1. Morris, S.: The nutritive value of proteins for milk production. III. The determination of the amino-acids of various feeds. *J. Dairy Res.*, **5**, 108, 1934.
2. Fowler, A. B., Morris, S., and Wright, N. C.: The quality of protein in relation to milk production. *Scot. J. Agric.*, **17**, 261, 1934.
3. Bell, G. H., and Morris, S.: The oxytocic property of the blood of the cow. *J. Phys.*, **81**, 63, 1934.
4. ————: The oxytocic property of the blood and its relation to milk fever in cows. *Brit. J. Exp. Path.*, **15**, 143, 1934.

5. Blackwood, J. H.: The absorption of milk precursors by the mammary gland. VI. The relation of phosphorus to the fat metabolism of lactation. *Biochem. J.*, **28**, 1346, 1934.
6. Blackwood, J. H., and Wishart, G. M.: The hydrolysis of lecitho-vitellin by pepsin and by trypsin-kinase. *Ibid.*, **28**, 550, 1934.
7. Howat, G. R., and Wright, N. C.: Factors affecting the solubility of milk powders. III. Some physico-chemical properties of concentrated solutions of milk solids. *J. Dairy Res.*, **5**, 236, 1934.
8. ———: The heat coagulation of caseinogen. I. The rôle of phosphorus cleavage. *Biochem. J.*, **28**, 1336, 1934.

39. DAIRY BACTERIOLOGY DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

The activities of the Division have been confined to the examination of official surprise samples of milk under the Sale of Milk Act (N.I.) 1927; and advisory work in relation to dairy routine on the farm and in the processing plant, and in connection with the cream export trade.

During the year under review investigations were carried out with a view to laying down bacteriological standards for graded milk. The standards adopted, as a result of this work, are published in "Statutory Rules and Orders of Northern Ireland, 1934" (Nos. 69, 70 and 71).

AGRICULTURAL ECONOMICS

40. AGRICULTURAL ECONOMICS RESEARCH INSTITUTE, OXFORD UNIVERSITY

The sugar beet industry.—When sugar manufactured from British grown sugar beet was first subsidised the Institute undertook to organise a study of the economics of sugar beet production throughout the country, and for nearly ten years the technical development and the financial and statistical position has been recorded year by year. A review of the progress of the industry and an estimate of its future has been made (2).

The dairying industry.—Work on the distribution side of the industry has been continued, but its form has been modified by the establishment of the Milk Marketing Board. The problem of maintaining a remunerative price in districts where production costs are high, in face of the breakdown under the pooling system of the local producers' monopoly, is being considered. Experiments in the supply of milk as a public service in other countries have also been studied.

The investigation organised by the Agricultural Advisory Economists' Committee of the cost of labour, foods and herd depreciation, in milk production in all the dairying districts of England and Wales has continued during the past year. Further work is needed before conclusive results can be obtained.

In the coming year, a study of costs of milk production throughout the country will be carried out by the Advisory Centres. The data collected will be summarised and examined by the Institute.

A survey of the economics of production of Grade " A " (T.T.) milk, which at present is excluded from the control of the Milk Marketing Board, has been commenced, in co-operation with several Advisory Economists.

Power farming.—The dry summers of the last two years have been particularly favourable to cultivation and harvesting by mechanical power. An economic survey of the use of the harvester-thresher in Britain has been started to provide further information as to costs and general experience. It is intended to visit all the users during the course of the survey.

A more particular study in progress is that of a small group of farms where horse labour has been superseded entirely by mechanical power. These farms present special problems apart from the mere question of comparative costs of operations and products, for the labour organisation is entirely different, and questions of displacement and casualisation have to be considered. A small group of such farms are being costed and observations made upon the labour organisation.

A study has been made of a large farm in Worcestershire, occupying more than a thousand acres, where, by the application of mechanical power, the area under market gardening cultivation has been increased four-fold without any displacement of, or addition to, the labour staff. A report on this farm is in the press, as one of the series of studies of notable achievements in farming, published by the Institute under the title of " Progress in English farming systems ".

Markets and prices.—The new policy of agricultural protection has already done much to affect not only prices of agricultural commodities but also the total quantities and the proportions derived from home, Dominion and foreign sources. The question of market supply has been studied during the year; the results have been summarised in a report now in the press.

The effect of a policy of restriction on the import of Dominion butter and cheese has been studied from the standpoint of the Dominion producer; the conclusion is drawn that prices would have to rise to levels at which consumption would be seriously affected before the Dominions producer would be adequately compensated for restriction of his output (3).

A report is being prepared on the prices of milk and milk products.

Information on the supplies and prices of pigs and pig products has been recorded throughout the year (14, 15). Notes have also been made on the effect of the bacon and ham import restrictions on retail prices. A study is in progress of egg prices and supplies.

Some further work has been done on the inter-relationships of the prices of beef, mutton and lamb, and on the elasticity of demand for these products.

Costing and farm finance.—A scheme for recording the cost of tractor work on various farm operations was prepared, and figures collected on a group of farms will be available for publication in the coming year.

A comparison has been made of costs and financial results on a group of poultry farms under different systems, such as poultry keeping as a specialised business and as an adjunct to mixed farming. The report will be issued during the coming year.

Full cost accounts have been kept on a small group of farms to provide general farm data. Results of practical application to farming have been published from time to time in the agricultural press.

The Institute is costing all the operations on the St. John's College Farm at Long Wittenham, where corn production by mechanical power is combined with an intensive pig feeding unit.

The problems of employment in agriculture.—The decline in the agricultural population, although apparently arrested in the last year, is one that has attracted a good deal of notice. It is not confined to Britain. The tendency of agricultural employment in this country is very uncertain, and it may ultimately be determined by the tendency of national policy. If the country must face indefinite competition with prairie and peasant countries, the standard of living on the land could only be maintained by a reduction of the rural population. Alternatively, if the market for home-grown perishable products and products of high quality can be developed, either under the influence of some control of imports or an improved consumers' demand, or both, there is a possibility of maintaining, if not of increasing agricultural employment. An investigation of this subject is in progress.

Titles of papers issued during the year.

(*a*) *BOOKS.*

1. The Agricultural register, 1933-34.
2. Bridges, A. and Dixey, R. N.: British sugar beet: Ten years' progress under the subsidy. *Oxford Agric. Econ. Inst.* 1934.

(*b*) *PAMPHLETS.*

3. Cohen, R. L., and Murray, K. A. H.: The effect of butter and cheese supplies on "surplus" milk prices. *Ibid.*, 1933.
4. Twenty-First Annual Report and List of Publications. *Agric. Econ. Res. Inst., Oxford*, 1934.

(*c*) *ARTICLES AND ADDRESSES.*

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6. ———: Agriculture and rural life. *Johnson's England*, **1**, ch. 10, Clarendon Press, 1933.
7. ———: Farm economics. *The Farmer's Guide to Agricultural Research in* 1932. *R.A.S.E.*, 87-107, 1933.
8. ———: The organisation of agriculture. *Nature*, **132**, 909-911, Dec. 16th, 1933.
9. ———: New policy for agriculture. *Yorks. Post Trade Rev.* Jan. 11th, 1934.
10. ———: Marketing schemes, I. Milk. II. Bacon pigs. *Manchester Guardian*, April 6th and 7th, 1934.
11. ———: The prospects of plough farming. *J. of Careers*, **141**, 277-282, May, 1934.
12. ———: The outlook for arable farming. *N.F.U. Yr. Bk.*, xxxvii-xli., 1934.
13. ———: Price fixing and farm management. *Home Farmer*, **1**, 26, September, 1934.
14. Murray, K. A. H.: Quarterly notes on prices and supplies. *Pig Breed. Gaz.*, November, 1933; February, June, August, 1934.
15. ———: A survey of the prices of pigs and feeding stuffs in England and Wales during 1933. *Nat. Pig Breed. Ann.*, 158-166, 1934-35.
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17. Cohen, R. L.: Agricultural reorganisation and price control. *Econ. J.*, **44**, 434-452, September, 1934.

(*d*) *PERIODICAL.*

18. Farm Economist, 1; 4, 5, 6 and 7.

41. FARM ECONOMICS BRANCH, DEPARTMENT OF AGRICULTURE FOR SCOTLAND

Economic position of agriculture in Scotland.—The fourth report on the profitableness of farming in Scotland, giving the financial results obtained on certain groups of farms during 1931-32 will shortly be published. The preparation of the next issue of this annual series is proceeding.

Cost of milk production.—Working in conjunction with this Branch the Agricultural Economics Departments at the three Agricultural Colleges have instituted an enquiry into the cost of milk production in different parts of Scotland. It is intended that this enquiry shall run for twelve months, in the first instance, and so provide data relating to the winter period 1934-35 and the summer period 1935. This work has been undertaken at the request of the Committee of Investigation for Scotland.

Economic survey of small holdings.—Some 200 financial records relating to the year 1933-34 have been collected from small holders in the lowland counties and a report on the data so obtained is in course of preparation.

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PRESERVATION AND TRANSPORT

42. DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

FOOD INVESTIGATION.

During the year, investigations have been in progress on the following topics. A full account of the work will be found in the Report of the Food Investigation Board for the Year 1934.*

LOW TEMPERATURE RESEARCH STATION.

(In conjunction with the University of Cambridge.)

Meat.—Physiology of muscle protein (27); evaporation of water from tissues (2); state of water in tissues; changes in the muscle pigments; changes in fat during storage (17, 18, 19); antioxidants and the preservation of edible fats; bacteriology (10, 11, 12).

Poultry and eggs.—Storage of poultry; the pH of the white of egg; bound water in thick and thin white; viscosity of the white and of the yolk; the vitelline membrane; strength of the vitelline membrane; yolk-fat; bacterial content of eggs; the yolk-index; storage of eggs.

Pork, bacon and hams.—Manufacture of Wiltshire bacon (5); gas-storage; the electrical resistance of muscular tissues; effect of rate of growth on muscular development; growth and conformation of the pig in relation to quality; chemical changes in the fat of bacon; micro-biology of pork and bacon.

Fruit and vegetables.—Injury in Australian apples due to carbon dioxide at low temperatures; effect of ethylene on apples at low temperatures: evidence for the production of ethylene by unripe, immature fruit; identification of ethylene among the volatile products of ripe apples; combustible gaseous products of fruits; effects of ozone on bananas; a toxic substance produced by yeast; effect of ammonia and of hydrochloric acid on the respiratory activity and the climacteric in apples; acidity and sugar-content of bananas during ripening; effect of temperature on the sucrose/hexose relation in potatoes; water relations of pea seeds; respiration of pea seeds; evaporation from plums; rotting of fruit in storage; absorption by grapes of iodine from iodized wraps; acidity and resistance to rotting in oranges; conditioning of cold-stored fruit prior to retail; effect of the box on the ripening of pears; bruise breakdown of apples; freezing of fruits and vegetables.

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* H.M. Stationery Office (in the press).

Canning.—Corrosion of tin; effect of various inorganic substances on the corrosion of mild steel by citric acid at about pH 3·5; corrosion of steel and tinplate by actual extracts of fruits; a survey of the inhibiting properties of English beet-sugars; diffusion of hydrogen through mild steel sheet and tinplate; corrosion of aluminium; use of aluminium cans for fruits; bacterial flora of sugar; changes in the pectin of fruits during storage; storage of strawberries for jam at — 5° C. after treatment by heat.

The preservation of vitamin C in canning fruits and vegetables.

Engineering.—Effects of the package on humidity and loss of water; leakage of heat into insulated holds (24); leakage of heat through recessed insulation; experiments on the leakage of heat through ships' insulation.

DITTON LABORATORY.

Fruit and vegetables.—Gas-storage of apples (15); internal atmosphere of apples in gas-storage; cause and control of superficial scald of apples; the cause and control of low-temperature breakdown in apples; metabolism of nitrogen by apple fruits during development on the tree and in storage.

Engineering.—Transfer of heat and water; stowage of cargoes of fruit; new methods of cooling ships' holds (22, 23); gas stores; ducts; fans.

Titles of papers issued during the year.

1. Adair, G. S. and Adair, M. E.: The determination of the isoelectric and isoionic points of haemoglobin from measurements of membrane potentials. *Biochem. J.*, **28**, 1230, 1934.
2. Brooks, J.: The vapour pressure isotherm of muscle. *Proc. Roy. Soc. B*, **114**, 258, 1934.
3. Bryan, J. M.: The effect of hydrogen-ion concentration on the rate of oxidation of solutions of ferrous citrate. *Trans. Faraday Soc.*, **29**, 830, 1933.
4. ————: The effect of hydrogen-ion concentration on the corrosion of iron. *Ibid.*, **29**, 1198, 1933.
5. Callow, E. H.: Bacon curing. The dry-salt and tank curing of Wiltshire sides. *Food Investigation Leaflet* No. 5, 1934.
6. Fidler, J. C.: Studies in zymasis. IV. The accumulation of zymasic products in apples during senescence. *Biochem. J.*, **27**, 1614, 1933.
7. ————: Studies in zymasis. V. Seasonal fluctuations in zymasis and in carbon dioxide/alcohol number ratios in apples in the absence of oxygen. *Ibid.*, **27**, 1622, 1933.
8. ————: Studies in zymasis. VII. The estimation of the ethyl alcohol and acetaldehyde content of apples. *Ibid.*, **28**, 1107, 1934.
9. Glennie, A. E., and Davies, G.: Index to the literature of food investigation, **6**, No. 1, March, 1934. H.M. Stationery Office, London.
10. Haines, R. B.: Further studies of the effect of the medium on the production of bacterial gelatinase. *Biochem. J.*, **27**, 466, 1933.
11. ————: The proteolytic enzymes of micro-organisms. *Biol. Rev.*, **9**, 235, 1934.
12. ————: The minimum temperatures of growth of some bacteria. *J. Hyg., Camb.*, **34**, 277, 1934.

13. Haines, R. B. and Smith, E. C.: The storage of meat in small refrigerators. *Food Investigation Sp. Rep.* No. 43, 1933.
14. ———: The handling of meat in small refrigerators. *Food Investigation Leaflet* No. 4, 1934.
15. Kidd, F., and West, C.: Gas storage of fruit. III. Lane's Prince Albert apples. *J. Pomol.*, **11**, 149, 1933.
16. Lampitt, L. H., and Moran, T.: The palatability of rapidly-frozen meat. *J. Soc. Chem. Ind. Lond.*, **52**, 143T, 1933.
17. Lea, C. H.: The action of light on fats. *Ibid.*, **52**, 146T, 1933.
18. ———: The influence of salts used in curing on the oxidation and yellowing of lard. *Ibid.*, **53**, 182T, 1934.
19. ———: Estimation of aldehydes in rancid fats. *Industr. Engng. Chem., Anal. Ed.*, **6**, 241, 1934.
20. Moran, T.: The freezing, storage and thawing of meat. *Food Manufacture*, **9**, 193, 1934.
21. ———: Progress in gas-storage for chilled meat. *Proc. Brit. Ass. Refrig.*, **30** (No. 2), 109, 1934.
22. Smith, A. J. M.: Some possible developments in the refrigerated transport of foodstuffs. *Trans. Liverpool Engng. Soc.*, **55**, 49, 1933.
23. ———: New method of cooling ships' holds, involving vertical air-flow for the cargo and a recessed jacket for heat leakage. *Ice Cold Stor.*, **37**, 21, 1934.
24. Smith, A. J. M. and Farmer, J. D.: The structure of insulated holds in relation to heat-leakage. *Trans. Instn. Nav. Archit., Lond.*, **76**, 52, 1934.
25. Smith, A. J. M.: The relations between yolk and white in the hen's egg. VI. The equilibrium between ice and egg-yolk, and the freezing-point difference between yolk and white. *J. Exp. Biol.*, **11**, 228, 1934.
26. ———: Gas control in holds. *Proc. Brit. Ass. Refrig.*, **30** (No. 2), 120, 1934.
27. Smith, E. C.: On the coagulation of muscle plasma. II. The solubility of myosin. *Proc. Roy. Soc.* B, **114**, 494, 1934.
28. Taylor, G. L., Adair, G. S. and Adair, M. E.: The precipitation reaction. Optimal proportions, neutrality and maximal precipitation in mixtures of albumin and antiserum. *J. Hyg., Camb.*, **34**, 118, 1934.
29. Thomas, M. and Fidler, J. C.: Studies in zymasis. VI. Zymasis by apples in relation to oxygen concentration. *Biochem. J.*, **27**, 1629, 1933.

43. FRUIT AND VEGETABLE PRESERVATION RESEARCH STATION, CAMPDEN, BRISTOL UNIVERSITY

CHEMICAL INVESTIGATIONS.

Internal rusting of cans.—Under certain conditions serious rusting of the under surface of the lids of cans may take place. Investigation showed that the rusting was closely associated with the ratio of carbon dioxide and oxygen in the headspace gases. Methods of reducing the risk of staining to a minimum and of removing the stain if formed have been described (1).

Gases in fruits.—A knowledge of the composition of the headspace gases is of value in diagnosing certain conditions in canned fruits. The composition of these gases is largely dependent on the nature of the intercellular gases originally present in the fruit. Analyses of the gases present in the raw fruits have been made during the past year.

Toughness of fruits and vegetables.—An investigation of the cause of toughening of the skins of processed dried peas undertaken in the previous year was extended during the past season to include fresh peas, beans, beetroots and a number of fruits. The factors chiefly studied were the action of hard waters used in the canning processes, the effect of ripeness of the fruit and of the strength of syrup used.

Hydrogen-ion concentration.—Adequate knowledge of the variation in the pH value of English canned fruits has not been available up to the present and, to fill this deficiency, many hundreds of determinations have recently been made at the Station.

Total acidity is also being determined and the influence of variety and degree of ripeness are being studied.

Changes during processing and storage.—Chemical changes due to diffusion—i.e. alteration in pH value, total acidity, density and degree of inversion—have been determined in a number of tests carried out during the past year. The object of the tests was mainly to ascertain whether the maximum toxic effect due to low pH value was attained in canned fruits when the conditions of maximum temperature were ruling. The subsequent rate of diffusion of the soluble material throughout the contents is also of importance in connexion with the examination of cans which have been recently packed.

Effect of soil type on colour of vegetables.—Beetroots and carrots have been grown locally on three different types of soils in the Campden area. Duplicate tests were made and the colour of the raw and canned products were compared by means of tintometer readings. The work is still in hand.

BACTERIOLOGICAL INVESTIGATIONS.

Thermophilic infection.—The work on thermophilic infection of canned vegetables has been carried a stage further. A typical "flat-sour" organism has been isolated from a heavily contaminated sample of foreign sugar; it is a facultative anaerobe and will germinate slowly at a temperature as low as 38° C. Thermal death-points have been determined in an apparatus specially constructed for this work and the results are being confirmed by inoculating cans of vegetables and processing under carefully controlled conditions.

Survey of commercially packed cans.—An extensive bacteriological survey of samples of commercially canned vegetables has been carried out during the year. The object of the work is to ascertain whether the canning processes recommended by the Research Station result in complete sterility of the products packed under all types of commercial conditions. The results obtained have been very satisfactory.

" *Bitter cream* " *organism.*—The preliminary work on the organism which produces a bitter flavour in canned cream has been completed. A description of the organism has been published (2).

MYCOLOGICAL INVESTIGATION.

Heat-resistant mould.—The mould *Byssochlamys fulva* causes serious trouble in canned and bottled fruits and a complete investigation of the problem is proceeding partly at the Imperial College of Science and Technology and partly at the Station.

A preliminary note on the work carried out in 1933 has been published (3).

The investigation during the past year was mainly concerned with the distribution of the spores in fruit plantations and orchards and the best means of destroying the infection after it has entered the canning factory. It was found that the mould was widely distributed over the main fruit growing areas and that the spores were carried into most factories on the surface of the fruits.

A memorandum was circulated before the beginning of the canning season giving suggested methods of controlling the infection in the canneries, and in all cases where the appropriate precautions were taken little trouble has been experienced.

BIOCHEMICAL INVESTIGATIONS.

Ripening of peas.—This work has now been in progress for three seasons. The rate of maturing of the whole crop has been determined each season, the factors observed including size and weight of peas and pods, yield, moisture content, ash, calcium content, sugar, starch and insoluble residue. The analyses are made on samples collected at two or three days' interval from the time the peas have formed until they are well past the stage at which they are normally canned. An attempt has also been made to follow the changes in pods of the same state of ripeness—samples being picked at regular intervals from the lowest flowering nodes only. By this means a better idea is obtained of the actual changes taking place in individual pods.

Composition of harvested peas.—Great variation is frequently noted in the properties of harvested English Small Blue peas required for canning. In this connexion the Station is working in close touch with the Midland Agricultural College and with a private firm at Bardney, where field trials have been carried out on the growing and harvesting of peas. The threshed peas are being examined at Campden both to determine their qualities in regard to canning and also to correlate any differences, with variations in chemical composition or in physiological structure.

PHYSICAL INVESTIGATIONS.

Vacuum in cans.—New methods of measuring the vacuum and headspace in cans have been published (4). The experiments are being continued in order to find a method of determining the vacuum without using an instrument which punctures the metal of the can.

Heat penetration.—Improved methods of measuring the rate of heat penetration in cans have been tested during the past year and a new apparatus is being used for tests on products of a solid or semi-solid nature in which the transference of heat is slow.

CANNING EXPERIMENTS.

The practical canning trials carried out during the year entailed the packing of over 10,000 cans and the number of individual experiments exceeded one thousand. These included tests on fruits, vegetables, soups, cream and certain marine products. Many cans were packed in connexion with the laboratory investigations which have been described in the previous paragraphs, and of the remaining tests the following were amongst the more important.

Hydrogen swells.—The results of a large number of experiments made in 1933 were available during the present year and revealed some useful information which should help towards a final solution of this important practical problem. Some of the points investigated were as follows:—(i) The effect of varying the composition of the steel used for the baseplate; (ii) the effect of decreasing the size of the crystals in the baseplate; (iii) the effect of varying the weight of tin coating on the plate; (iv) the action of certain inhibitors in the syrup used for covering the fruits, particularly the effect of the pH value on the efficacy of inhibitors; and (v) the relationship between the ripeness of the fruit and the rate of formation of hydrogen swells.

Promising results were obtained in the tests in which the composition of the steel was the factor studied, and full-scale commercial trials have been made during the past season on the types of plate which were found to be most satisfactory in the Campden experiments.

A summary of the results of the tests made at the Station during the past five years has been issued (5).

Lacquer tests.—Thirty tests were made on new lacquers or new methods of lacquering the cans used for packing fruits and the knowledge of this subject has been advanced a stage further. Serious discoloration sometimes occurs in canned fruits which have been stored for periods of a year or more, and the most recent tests have shown how this deterioration can be safely avoided by improved methods of lacquering.

Variety trials.—Following the practice adopted in previous seasons, many new varieties of fruits and vegetables were tested. The results of the experiments have been published (6, 7).

Grading of vegetables.—Prior to the present season there had been no recognised standards for the grading and packing of vegetables in cans. Suggestions were put forward (8) and these were accepted by the Campden Technical Advisory Committee and were adopted tentatively as National Mark standards for the 1934 season.

BOTTLING TESTS.

Further experiments were made on speeding up the bottling process and special attention was given to " rising " of the fruit and to covering the fruit with light or heavy sugar syrups instead of water.

Titles of papers issued during the year.

1. Horner, G.: The internal rusting of cans. *Ann. Rep. Fruit and Veg. Preservation Res. Sta.*, 43, 1932-33.
2. Macmaster, N. B.: Bitterness in canned cream. *Ibid.*, 71, 1932-33.
3. Hirst, F. and Macmaster, N. B.: Preliminary report on the heat-resistant mould *Byssochlamys fulva.* *Ibid.*, 53, 1932-33.
4. Adam, W. B. and Stanworth, J.: Vacuum and its measurement. *Ibid.*, 61, 1932-33.
5. Hirst, F. and Adam, W. B.: Notes on hydrogen swells and perforations. *Third Suppl. Canners' Bull. No.* 1. *Fruit and Veg. Preservation Res. Sta., Campden, Glos.* Sept., 1934.
6. ————: Varieties of fruits—Canning trials. *Ann. Rep. Fruit and Veg. Preservation Res. Sta.*, 24, 1932-33.
7. ————: Varieties of vegetables—Canning trials. *Ibid.*, 28, 1932-33.
8. Adam, W. B.: Grading and packing of vegetables for canning. *Ibid.*, 34, 1932-33.
9. Hirst, F.: Problems in connexion with the exporting of canned fruits and vegetables to the hotter parts of the Empire. *Food*, December, 1933.

AGRICULTURAL ENGINEERING

44. AGRICULTURAL ENGINEERING RESEARCH INSTITUTE, OXFORD UNIVERSITY

Power and power units.—Work on the dynamics of tractor wheels has been continued and extended. Several important advances in theory and technique have been made during the year, and apparatus for wheel testing embodying these improvements is approaching completion.

A study of the theory and practice of tractor dynamometry has been completed. Several sets of the Institute's design of traction dynamometers have been supplied to other Institutions at home and in the Empire for tractor testing, and an improved design is nearing completion.

A small orchard and nursery garden motor cultivator has been acquired during the year and has been reconstructed to embody certain features which considerably improve and extend its work.

An encouraging feature of the past year has been the appearance of three new tractors of English manufacture, while a fourth which is still in process of development has been given a research test.

Two producer gas attachments suitable for tractors and capable of utilising any fuel from charcoal to anthracite, have been investigated during the year, but the makers have not yet been able to provide tractors so fitted for an extended test under normal working conditions.

The use of electricity on farms continues to make fair progress; improvements which have come to the notice of the Institute during the year include a cheap and practical sterilizer for dairy purposes which was produced at the instigation of the Institute on the lines of a similar American unit.

At the request of the Electricity Commissioners two members of the staff made an independent survey of the conditions in the Bedford Demonstration area in October and reported to the Conference on Electricity Supply in Rural Areas. Requests for a similar investigation have been made by two other areas.

The Institute is collaborating with Rothamsted Experimental Station in an investigation of the relative costs of electric motors and tractors for driving stationary barn machinery under farm conditions.

A paper on pumps for farm use has had a wide circulation (3). A further paper on electrical wiring systems for farms is nearing completion. Work has already begun on the study of milk cooling units and refrigerators for farm use.

Implements and cultivation.—The excellent harvesting conditions of the past two seasons have given the combine-harvester little opportunity of showing its full capabilities. Some 60 of these machines were at work this year, including a new Australian machine of somewhat revolutionary design, and a mass of data, including costs, was secured. In view of the accepted position of the harvester in English farming, further work on the costs of this system is being handed over to the Institute for Research in Agricultural Economics.

During the next season work will be confined mainly to the question of the collection and disposal of combine straw, and it is hoped that it will be possible to introduce a new straw trussing attachment from abroad for trial.

Two new small combines have appeared this season in Germany and the U.S.A., and as these will be economically possible on considerably smaller farms than the standard pattern, it is hoped that they may be introduced to this country next season.

An increasing proportion of the final separation of grain is being done by stationary machinery, in order to reduce the weight of the harvester-thresher. The stationary cleaning machinery used on the farm is generally far behind that installed in flour mills, although better cleaning of grain (particularly of malting barley) would enable the farmer to obtain an appreciably better price. Three machines of a type new to British farms, though extensively used in the U.S.A. and in the grain cleaning plant of flour mills, have been loaned to the Institute, and set to work at selected farms in the Survey; while an experimental machine of the same type has been promised for installation in the Institute's machine room, where a demonstrator aspirator (of the vertical wind channel type) is already installed.

Work has been continued and extended on the production of high moisture content baled hay under controlled conditions with very satisfactory results. Sufficient data have now been acquired to make it clear that the use of the combine hay baler introduced to this country by the Institute possesses no advantages over the alternative system of baling in the field with a stationary baler, using motor sweeps to bring in the crop to the machine.

Several new types of tractor plough embodying important developments have been inspected at work this season, and the Institute has closely followed the advances made in gyratory cultivation. Two new models of the gyrotiller made their appearance this summer, and may be regarded as important additions to the range of heavy machinery available to the agricultural contractor, apart from their great uses in tropical cultivations.

A new type of trench excavator developed by an Oxford firm of engineers has been closely followed. This machine promises to be of considerable value in making possible the laying of underground electric cables and water mains across open country.

The Institute has been co-operating with the Welsh Plant Breeding Station at Aberystwyth over the question of implements for the reclamation of rough grazings in the Cahn Hill Improvement Scheme, in which results of great interest are being secured, and the Director has made two visits to Pwllpeiran and the other Stations of this scheme in connection with the engineering aspects of this work.

There has been one important addition to the number of commercial spacing drills during the year. As a result of a laboratory examination of this, certain improvements were suggested and adopted which have markedly increased its efficiency. It is hoped to continue work on this subject during the coming year.

The work on root crop cultivation has now been transferred to the Institute's field station at Benson, where some three acres of sugar beet have been grown for the purpose. In the course of the season the Siedersleben beet lifter has been completely rebuilt, and will be used in its modified form to harvest the crop, together with a pneumatic wheel trailer specially designed for the purpose. Blue prints of a similar trailer have been made available to the public under the " data sheet " scheme.

The work on the control of weeds by sulphuric acid has been continued, with special emphasis on the reduction of the time taken and the simplification of the mixing of the dilute acid (4). An important extension of this technique as a method of control of blight in potatoes has been evolved.

Weed control by acid spraying was again the subject of a co-operative scheme on the Magdalen College estates, and was highly successful.

Work on mole draining has been affected by the dry season, which has made it impossible to secure any results of value, but advances have been made in the experimental technique. The use of mole draining tackle for rapidly laying piped water supplies in farms has been observed, and appears to offer a considerable saving over hand excavation. Similar equipment has also been used by the G.P.O. recently for buried telephone cables.

The work on malting barley, to which reference was made in the last report, is being continued. It is gratifying to note that the prejudice against malting barley from combine-harvesters which manifested itself last season in many districts has now been overcome, and " combined " malting barley now finds a good sale, on the condition that it is " declared."

Survey of mechanized farms.—The survey of mechanized farms has been continued. Several more farms have been added to the Survey this year, and others are under consideration.

Much of the work described in the previous section of this report has been carried out in farms on the Survey; apart from this, and from voluminous figures on the costs of various farm operations, considerable knowledge has been secured of the power requirements and behaviour of standard implements and tractors under the most diverse conditions of soil and climate, and numerous dynamometer measurements have been taken of machines at work. An important paper has been published dealing with the technique of mechanized farming as practised in England to-day (5).

Special mention must be made of the very helpful and generous spirit in which the owners and tenants of these farms have made the Institute free to inspect their figures and costings, and have given facilities for the carrying out of experiments, often at considerable inconvenience to their own operations.

Testing.—Tests were completed on the Miller spacing drill, a report of which has been published, and on the Dunlop pneumatic tractor wheels, the report of which is in preparation; while a new British tractor has been entered for testing. Tests were carried out on behalf of the Royal Agricultural Society on tractor wheels, on a tractor and on a stationary compression-ignition engine, as entrants for the Society's Silver Medal.

It should be more widely known that the Institute also carries out confidential or research tests, in which the results are communicated to the entrants only, and are not otherwise published. One major test of this type has been made during the year, on a new British light tractor.

Titles of papers issued during the year.

1. *Farm and Machine*, **1**, 1934.
2. Abstracts of Current Literature, 9-12, October, 1933—July, 1934.
3. Brown, C. A. Cameron: Pumps for farm water supply, 1934.
4. MacDowall, R. K.: An improved method for the handling and dilution of sulphuric acid for spraying weeds, 1934.
5. Newman, J. E.: Notes on the technique of mechanized farming, 1934.
6. Blackaby, J. H.: Automatic meter for measuring the outflow from field drains. *Engineering*, Jan. 19, 1934.
7. ———: Land drainage machinery. *Ibid.*, Dec. 29, 1933.
8. Denham, H. J.: Economies in arable cultivation. *The Field*, Dec. 2, 1933.
9. ———: Notable farming enterprises IV. A commercial experiment in poultry farming. *J.R.A.S.E.*, **94**, 1933.
10. Wright, S. J.: Farm implements and machinery. *The Farmer's Guide to Agricultural Research in* 1932. 1933.
11. ———: Equipping the mixed farm. *Farmer and Stockbreeder*, May 7, 1934.
12. Brown, C. A. Cameron: Electricity in horticulture, *The Times*, Electricity Supply Number, Dec. 5, 1933.
13. Newman, J. E.: Tractor horse power. *Worcs. C. C. Agric. Quart. Chron.*, 15, 1933.
14. ———: Trends in tractor design. *Farmer and Stockbreeder*, July 2, 1934.
15. ———: New hay and harvesting methods. *Ibid.*, May 7, 1934.
16. ———: Installing the water supply. *Ibid.*, September 3, 1934.
17. ———: Power speeds up autumn work. *Ibid.*, September 3, 1934.
18. ———: Possibilities before English agriculture, *J. Yorks. Agric. Soc.*, 1934.
19. ———: Experiences of another harvest; work of different types of combine. *The Field*, September 29, 1934.
20. MacDowall, R. K.: Fighting corn crop weeds. *Farmer and Stockbreeder*, May 14, 1934.

II

LOCAL INVESTIGATIONS AT ADVISORY CENTRES

CHEMISTRY

45. ABERYSTWYTH: UNIVERSITY COLLEGE OF WALES

The results of the following investigations have been published (1, 2) :—

(i) The effect of manures at different altitudes on the nitrogen and mineral content of grass and clover species.

(ii) The recovery of nitrogen in pastures from the application of nitrogenous manures.

The following problems are under investigation :—(*a*) A study of the principal chemical changes taking place on the conversion of grass into ensilage (3rd Year) ; (*b*) the composition of the grain and straw of varieties of oats bred at the Welsh Plant Breeding Station with the object of ascertaining their suitability to our conditions (2nd Year) ; (*c*) a study of the chemical composition of the by-products obtained in the milling of the above varieties of oats (2nd Year) ; (*d*) a further study of the nutritive value of the edible weeds of pastures ; and (*e*) the effect of deposited mineral matter from a polluted atmosphere upon the surrounding pastures.

Reference was made in the previous report to two types of silage prepared at the College Farm, Nantcellan. This work has been continued and extended ; four types of silage were made by the following processes :—(i) Defu ; (ii) Molasses ; (iii) A.I.V. ; and (iv) Ordinary.

The material made into silage was meadow hay, the intention being to procure this in a young leafy condition. Unfortunately the drought of the early summer caused the herbage to run to stem with the result that it was more fibrous than was desirable.

The produce of each silo was fed to cattle and their order of palatability judged by the manner in which they were consumed was as follows :—Molasses, Ordinary, Defu and A.I.V. The percentage loss of dry matter in the different methods of preservation was as follows :—Molasses 9·3 ; Defu 9·5 ; A.I.V. 15·5 ; and Ordinary 28·0.

Titles of papers issued during the year.

1. Fagan, T. W., and Milton, W. E. J.: The effect of manures at different altitudes on the nitrogen and mineral content of grass and clover species. *Welsh J. Agric.*, **10**, 174-189, 1934.
2. Fagan, T. W., and Davies, R. O.: The recovery of nitrogen in pastures from the application of nitrogenous manures. *Ibid.*, **10**, 190-196, 1934.

46. BANGOR: UNIVERSITY COLLEGE OF NORTH WALES

In the soil survey of Wales, mapping has been carried out in N. Denbighshire. There is now a completed band of surveyed country from East to West. The methods of survey worked out in collaboration with other soil surveyors have proved satisfactory, and the soils encountered have generally fallen within the series already recognised.

In the laboratory, representative profiles of the chief soil series have been examined with a view to more precise definition, and in this respect the study of the composition of the clay fraction is proving of great value. It is highly desirable that the specification of the soil series should be based on objective and quantitative data rather than on the subjective and qualitative data of field observations.

The rate of loss of lime from soils under N. Welsh conditions have been investigated. As a first approximation, a figure of 100 lb. per acre per annum of CaO may be given. The rate of loss rises with the base status, and it may be possible to suggest the rates at which calcareous dressings should be given in order to maintain any given level of base-saturation.

An investigation of the composition of locally grown feeding stuffs has been begun. This will naturally extend over several years.

Titles of papers issued during the year.

1. Robinson, G. W.: The analysis of soils. *Times Trade and Eng. Suppl.*, 3rd March, 1934.
2. ———: The soils of Wales. *Emp. J. Exp. Agric.*, **2**, 7, 258-273, 1934.

47. BRISTOL UNIVERSITY

Grassland investigation.—Further sections of this investigation, which has been in progress for several years, have been completed, and the Department is now in possession of critical data upon the following aspects of grassland :—

(*a*) The effect of different systems of manuring and management on the nutritive value of grass and hay.

(*b*) The influence of local conditions of soil and climate in the West Country on the nutritive value of herbage.

(*c*) The monthly nutritive value of the herbage of water meadows, cow-pastures and Wiltshire Down land under conditions of both good and bad management.

(*d*) The " mineral " content of West Country pastures.

(*e*) The iodine content of certain pastures.

(*f*) The effect of folded poultry on the chemical composition of relatively poor pastures.

(*g*) The losses that occur in the making of grass silage in the stack, with and without the use of molasses, A.I.V. solution and ordinary water.

Teart land.—No further progress has been made in the elucidation of the Teart problem in Somerset owing to the prolonged drought which again prevented the occurrence of the condition in the affected area.

Dried poultry manure.—Experiments are being conducted at five centres in the Bristol Province. These experiments have been designed in order to test the manurial value of this substance for market garden and vegetable crops.

Pig husbandry.—In the spring of 1934, the Experiments Committee of the Bath and West Society commenced a study of the systems of pig husbandry in the seven South Western counties. The Adviser and the County Agricultural Organiser for Wiltshire are acting as joint honorary investigators.

Poultry.—Coincident with the increasing activities in the recently established Poultry Pathological section, problems concerning the nutrition of poultry are now receiving considerable attention.

Other investigations.—Investigations with regard to (*a*) the chalk soils of Wiltshire and Hampshire, and (*b*) the relative value of sugar beet factory waste lime, are being carried out in collaboration with Advisory Chemists at other centres.

Titles of papers issued during the year.

1. Ling, A. W.: The soils of Gloucestershire. *Gloucs. Farmer*, **2**, 1, Jan., 1934.
2. ———: Some observations on the soil of the spring cabbage manurial trial plots at Perdiswell. *Worcs. Chron.*, **2**, 2, Feb., 1934.
3. ———: Summer feeding to meet the milk prices. *Farmer and Stockbreeder*, 14th May, 1934.
4. ———: West Country pastures, month by month. *Farmers Weekly*, 14th Sept., 1934.
5. Ling, A. W., Muir, W. R., and Nutt, J. D.: The Longleat Experiments 1927-1931. *J. Bath and West and Southern Counties Soc.*, **8**, 1933-1934.

48. CAMBRIDGE UNIVERSITY

Soil acidity.—Further yield data have been obtained from the liming experiments established in conjunction with County Organisers in previous years. Results show that on the lighter types of soil (loamy sands) in the Eastern part of the Province, very slight acidity is sufficient to bring about a statistically significant decrease in the yield of sugar beet. Experiments on the effect of soil acidity on the chicory crop show that there is little difference in the susceptibility of the two crops to soil acidity.

Phosphatic manures.—Trials have been carried out on the effects of the cheaper phosphatic manures on Fen-peat and " Skirtland " soils compared with the results obtained from superphosphate. The results show that the latter is much superior to ground mineral phosphate. The yield differences between superphosphate and basic slag were not significant.

Manuring of chicory (for drying).—The results from the 1933 trials have been worked out but no very significant results have been obtained. The trials are being continued for a third season.

Use of combined seed and manure drills.—Trials on barley were again carried out at two centres. At one centre the crop was attacked by wireworm with very interesting results. The unmanured plots were almost cleared of plants by the wireworms, the plots on which the manures were broadcast suffered a very serious reduction in final yield, whilst the combined drilling, though checked to some extent, suffered only slight reduction in plant population and produced a moderate yield of grain for such a light chalky soil.

At the second barley centre, the differences in yield between the two methods of applying the manures, i.e. broadcasting and drilling with the seed, were not significant.

Experiments on the comparison of ploughing-in *versus* broadcasting of fertiliser for barley and sugar beet yielded no data of any value this season.

Provincial experiments.—Co-operation has continued in the provincial experiments on the intensive management of grassland and a new series of provincial experiments dealing with the manuring of vegetable crops was begun in 1934 and it is hoped will continue over a period of years.

Titles of papers issued during the year.

1. Hanley, F.: Eastern Counties provincial cockerel breeding scheme. *Essex Agric. Comm. Reg. of Egg Records*, 44, 1932-33.
2. ————: Experiments on the value of decorticated sugar-beet seed. *J. Min. Agric.*, **41**, 21, 1934.
3. Woodman, R. M., Brenchley, G. H., and Hanley, F.: Soil treatment for brassicae. I. The effect of sterilisation of the soil by mercuric chloride on the seedling growth of brussels sprouts. *J. Soc. Chem. Ind.*, **53**, 35T, 1934.

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49. HARPER ADAMS AGRICULTURAL COLLEGE

Soil survey.—The survey of the soils of North Shropshire has been completed. It comprises an area of 192 square miles (122,880 acres). Twenty-four soil series have been recognised. The number of types per series varies from two (in 13 of the series) to nine in the most comprehensive (1, 2).

"*Grey speck*" *in oats.*—This disease, usually considered to be associated with manganese deficiency, has occurred in Warwickshire. Experiments have been undertaken in 1932 and 1934. The results of the 1934 experiments tend to show that a considerable degree of control can be obtained by dressing the soil (prior to seeding) with 1 cwt. of manganous sulphate per acre. A heavy dressing of farmyard manure also proved beneficial.

Soil acidity.—An experiment (Class A 4 × 4 Latin square) previously reported has been continued using swedes as the crop. At a pH. of 4·8 the crop was a failure. At 5·3 the crop might be considered as being fairly satisfactory. At 5·6 the yield was quite satisfactory. The lime (CaO) content of the leaves increased with the dressings from 1·48 per cent. to 3·06 per cent.

Mineral content of pastures.—Work on this subject has been initiated and needs to be prosecuted more intensively in connection with treatment as applied to the various soil series.

Sugar beet factory waste lime.—In co-operation with the Bristol Province and the sugar beet factories at Allscott and Kidderminster, an experiment designed to test the efficacy of factory waste lime in removing soil acidity has been laid down and is still in progress.

Silage.—In co-operation with a private firm an experiment has been undertaken to investigate the value and nature of silage made from meadow aftermath, both untreated and sprayed with acid and molasses.

Grassland.—Preliminary experiments on the effect of liming on grassland have been undertaken. Three areas were chosen on which differential lime treatments were given and the mineral status of the herbage determined.

Titles of papers issued during the year.

1. Davies, W. M., and Owen, G.: Soil survey of North Shropshire. Pt. 1. Geography geology, parent materials, soils. *Emp. J. Exp. Agric.*, **2**, 6, 178-188, 1934.
2. ———: Soil survey of North Shropshire. Pt. 2. Classification of series and types. *Ibid.*, **2**, 8, 359-379, 1934.

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50. LEEDS UNIVERSITY

Sugar beet experiments.—The effect of common salt on the yield of sugar beet, adequately supplied with other forms of fertilisers, was tested in quadruplicate plots at three centres. An application of 5 cwt. salt per acre produced a significant increase of washed roots at all centres, 10 cwt. produced an increase at two centres, whilst 15 cwt. an increase in one centre, a depression in another, and no effect in the third. Common salt did not apparently affect the sugar content.

Two other experiments were conducted on the manuring of beet, one to test the effect of early *versus* late application and the other to test the effect of increasing the quantity of artificial fertilisers. In the first experiment early applications were found to give slightly larger yields.

Gas by-products.—Numerous field experiments were carried out with a concentrated form of gas liquor and gas liquor salts to test both the availability of the nitrogen in the two materials and the weed killing powers of the liquor. It was found that the two had distinct possibilities as fertilizers, and that the liquor could be used as a means of controlling weeds in cereals.

Potato eelworm control.—The effects of mercuric chloride and of potash on the growth of potatoes in land affected with eelworm were tested in one centre. Both treatments increased the yield, the mercuric salt to the extent of about 300 per cent. The tubers grown in the mercury plots were entirely free from common scab, the rest being badly affected.

51. MANCHESTER UNIVERSITY

Quality of hay.—An investigation has been commenced on the quality of the hay crop from some Lancashire and Cheshire farms. From results obtained during an economic examination of these farms hay seemed to be playing an unduly small part in the system of feeding. The ordinary feeding stuff analysis failed to show sufficient marked differences between the hays and attention is now being paid to the ash constituents as it is possible that the poor feeding value is connected with a low mineral content.

Effects of lime and fertilisers on the mineral content of poor pastures.—The extent of the increase in mineral content of pasture grass is being examined following the application of lime and several phosphatic fertilisers. On plots which were treated in the autumn of 1930 a 500 per cent. increase is now shown in the lime content of the grass but the phosphate content is only slightly increased. Mechanical treatment, i.e., harrowing, combined with the fertiliser treatments, showed a further increase in mineral content.

Wool shoddy manure.—The experiments commenced last year on the use of wool shoddy have been continued and comparative experiments with farmyard manure were carried out at four centres. The results confirmed those of last year in showing that shoddy, particularly the grade known as short shoddy, is a useful nitrogenous manure and that best results are obtained when it is ploughed in during the early spring.

52. MIDLAND AGRICULTURAL COLLEGE

Molassed beet pulp (taint in milk) enquiry.—The fourth year's work dealing with this investigaton was commenced in the spring of 1934. The chemical changes involved during the heating of betaine are being studied. Later this season it is proposed to examine the gases evolved during the drying of molassed beet pulp under factory conditions and thereby to obtain a complete picture of the changes occurring during the preparation of this foodstuff.

Composition of milk.—In the previous year data concerning the fat and solids-not-fat contents of Friesian milk were collected by the systematic recording of the bulk milk of six pure bred herds. This year the recording of the composition of the milk of individual cows in one herd has been commenced. The breeding history of this herd is available and it is proposed later, when adequate data have been obtained, to ascertain whether low and high solids-not-fat percentages are inherited factors or not.

Composition and use of sewage sludge.—Further samples of this material have been collected and analysed. In co-operation with the Horticultural Organiser for Nottinghamshire, experimental plots were laid down this season on an allotment in the vicinity of Nottingham.

Hardness in canned peas.—A canning factory in Lincolnshire has recently requested help in determining the factors responsible for the hardness frequently met with in processed peas. This question is one of major importance to the pea canning industry and since this factory alone takes the produce of over 1,000 acres in the Midland Province it was decided to undertake an investigation into this problem. This season, soil, cultural, harvesting and other data are being collected from 20 fields in the factory area and samples of peas from these various fields submitted to canning tests and chemical analysis. Manurial experimental plots are contemplated for next season.

Manganese deficiency in soils.—Cases have recently come to our notice of the failure of oats on certain humous sandy soils, the symptoms being those of the deficiency disease known as "grey speck", which is stated to be due to a deficiency of available manganese in the soil. A series of plots were laid down in Derbyshire this year and samples of the oats at various stages of growth taken and analysed. Further work on this problem is projected for next season.

Arsenic content of turkeys.—During 1933-34 the Veterinary Adviser for Derbyshire undertook a number of experiments to observe the effect of injections of neo-salvarsan in controlling blackhead in turkeys and at his request numerous analyses were made of the flesh, organs and feathers of turkeys so treated with the object of ascertaining the amount of arsenic retained by the birds.

In no case was the amount retained sufficient to cause the slightest alarm to the consuming public.

Liming experiments.—A series of plots involving six randomised blocks of eight plots each was laid down this year on the Bunter Sands at Babworth in North Notts. Yield data from this series and also from the series laid down the previous year at Clipstone are being collected.

Analysis of fodders.—In co-operation with the Advisory Chemists in other areas, further work in connection with the determination of the nitrogenous constituents of fodders has been carried out.

Improvement of lawns.—Plots have been laid down this year in the College gardens to try the effect of slow acting organic manures on lawns.

Titles of papers issued during the year.

1. Cranfield, H. T.: Cod liver oil for animal feeding. *The Derbyshire Farmer*, **13**, 11, Nov., 1933.
2. ———: Metals and their effect on milk and milk products. *Ibid.*, **14**, 7, July, 1934.
3. Cranfield, H. T., Roebuck, A., and Stafford, J. G. W.: The control of mites in cheese stores. *J. Min. Agric.*, **41**, 4, July, 1934.

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53. NEWCASTLE: ARMSTRONG COLLEGE, DURHAM UNIVERSITY

The composition of draw-moss or sheathing cotton sedge (Eriophorum vaginatum).—Samples were obtained in the spring of 1933, with a view to ascertaining whether the value of draw-moss is due wholly to its timely availability during a difficult period of the year or, in part, to feeding qualities exceptional in moorland plants. It was also desired to find whether the scallion differed materially in composition from the green leaf, and to determine the changes in feeding value which might occur as the season advanced.

The results of this work have been recorded in a paper now in the press. Briefly, it was shown that while the feeding value of the plant as a whole does not decline markedly with the advancing season, the early spring scallion is superior to the aerial portions, and is of greater value then than at a later stage. One outstanding fact was revealed, viz., that the phosphoric acid content of the drying matter is very high in all samples and, in the early spring scallion (.94 per cent.), approximates to that in pasture grass of the highest quality. On the other hand, the lime content is exceptionally low.

It appears, therefore, that draw-moss is complementary in respect of its chief ash constituents to common heather which, as has been shown, has a fairly high lime content and is poor in phosphoric acid. Especially is this so in early spring, when draw-moss is of highest nutritive value, and heather is poor and little eaten.

Investigations in progress include the following :—

(a) The yield and composition of grass from the Tree Field plots at Cockle Park : this work has been continued on the same lines as in 1930 and 1933.

(b) Variation in the composition of winter grass : a report on the preliminary investigation carried out during the winter of 1932-33 is in course of preparation. The work is being carried further on two paddocks on Roundabouts Field at Cockle Park, specially laid up in July, 1934.

(c) The yield and composition of pasture grass from intensively and non-intensively treated areas on Roundabouts Field at Cockle Park.

(d) The effect of drainage on the yield and quality of pasture grass : the drainage plots on North Field, Paradise (Cockle Park), are being utilised for this work.

(e) The composition of common heather and other moorland plants of reputed economic importance : special attention is being given to seasonal variation, and to the effect of age on digestibility.

A field trial involving the application of fertilisers to newly burnt heather has been commenced.

The composition of bell heather (*Erica cinerea*) and of stool bent (*Juncus squarrosus*) is being studied.

Titles of papers issued during the year.

1. Thomas, B.: On the composition of common heather (*Calluna vulgaris*). *J. Agric. Sci.*, **24**, 1, 151-155, 1934.
2. ———: On the yields and composition of meadow hay from certain of the Palace Leas plots at Cockle Park. *Ibid.*, **24**, 3, 379-389, 1934.
3. ———: The pollution of farm water supplies by sewage effluents. *Agric. Prog.*, **11**, 164, 1934.
4. ———: Water supplies for farm livestock. *Northumberland Milk Rec. Soc. Offl. Handbk.*, 1934.
5. Thomas, B., and Elliott, F. T.: A new assessment of the effects of manuring on the tree field plots at Cockle Park. *J. Bath and West and Southern Counties Soc.* 6th Series, **8**, 37, 1933-34.

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54. READING UNIVERSITY

Solids-not-fat in milk.—A full report of the investigations conducted between 1930 and 1933 into this problem has been published (1), and certain lines of investigation are still being followed up.

Evidence has been obtained of the serious nature of this problem and the extent to which cows in certain herds gave milk deficient in solids-not-fat, and that such cows also generally gave milk deficient in butter fat. The chemical composition of such abnormal milk has been investigated and discussed. The results of freezing point tests indicate that the freezing-point of genuine but abnormal milk is practically the same as that of normal milk: it follows that this test should be of value in detecting the adulteration of milk with water.

The low content of solids-not-fat was unaltered by the introduction of certain changes in the diet and there is still no known method of raising the level of solids-not-fat content of the milk of cows over any lengthy period.

Soil survey.—An intensive survey of the Eastern portion of the Vale of the White Horse has been completed, and a full report on the work is being published shortly.

The area has been mapped, the soils classified on the basis of profile characteristics and grouped into twenty soil series. The chemical and mechanical composition of the various soil types has been discussed in detail. The suitability of a number of the soils for fruit growing, which is an important industry in certain localities in the area surveyed, has been described.

Other investigations.—These include the following:— (a) The effect of manuring on the chemical composition of grass and hay for cattle; (b) the cultural treatment of marrow-stem kale; and (c) the nutrition of bulbs, and chlorotic conditions in horticultural crops.

Title of paper issued during the year.

1. Nicholson, M. N., and Lesser, C. E.: Investigations into the problem of milk with a low content of solids-not-fat. *U. Reading Bull.* No. 46, 1934.

55. SEALE-HAYNE AGRICULTURAL COLLEGE

Soil factors influencing crops.—Of the ordinary farm crops, mangolds have provided the material for interesting work. The problem with regard to grass, cereals and the other root crops has, for all practicable purposes, been disposed of.

Strawberry patch disease.—The work outlined for the previous year is being continued along the same lines and considerable progress has been made.

Potato eelworm disease.—Further experimental work was carried out during the past year with striking success. A report of the trials and observations is being published.

Failure of mangolds.—A case, apparently due to the growing of mangolds on the same land eight years previously, is being studied from the point of view of soil balance.

Narcissus.—The soil as the cause of blindness in certain varieties of narcissus is also being studied.

Soil survey.—Considerable progress has been made both in mapping and correlation of soil series from analytical data of profile samples.

56. WYE, SOUTH-EASTERN AGRICULTURAL COLLEGE, LONDON UNIVERSITY

Blackening of potatoes on cooking.—Three cases were dealt with and an examination made of the soils on which the potatoes were grown. The first case arose in the previous year and in order to ascertain the effect, if any, of manuring, a small field trial was arranged. The trial was made with (*a*) seed grown on the same field in the previous season, and (*b*) new Scotch seed of the same variety. The manuring was designed to test the influence of extra potash and manganese, and a combination of these two. At harvest time samples of potatoes were taken from each plot and submitted to cooking trials in the College kitchen. The potatoes judged to blacken least were those which had not received extra potash. No effect could be observed from manganese alone, but when applied with potash the flavour and appearance of the potatoes were improved. In the other two cases the soils were found to be normal and the manuring was regarded as suitable. The darkening on cooking varied with the variety; in one case " white " potatoes were worse than King Edward and in the other case the reverse. The evidence generally pointed to the trouble being seasonal and varietal.

Lime-induced chlorosis.—Severe injury was caused to the trees in the pear orchard at Chart Sutton by lime-induced chlorosis. Some improvement was observed in the portions dressed with sulphate of potash and sulphate of ammonia respectively. This improvement may have been due in some part to a reduction in the seepage water (highly charged with lime salts), brought about by the piping of a stream running along the higher ground at the top of the orchard, and by the dry season. Ash analysis were made on the yellow leaves from the worst of the chlorotic trees and on the green leaves from the less affected trees. The green leaves contained 44·28 per cent. CaO and 10·17 per cent. K_2O, and the chlorotic leaves 31·19 per cent. and 21·15 per cent. respectively, a result which is similar to that recorded for chlorotic apple leaves.

Spraying of hops.—It was ascertained that the spraying of hops with Bordeaux mixture does not increase the normal rate of corrosion of the wirework.

Spraying trial.—The spraying trial against apple scab in the College plantations was continued on the same lines as in 1933 (1). The trial is designed to test the value of Bordeaux mixture over a period of ten years.

Fruit soils.—Although no systematic survey of fruit soils is now being made a considerable number of these soils has been dealt with, largely as a consequence of advisory work. The need of potash on soils which were being planted up and confirmation of its deficiency in cases of indifferent growth or actual disease have been repeatedly shown on laboratory examination.

Title of paper issued during the year.

1. Goodwin, W., Martin, H., Salmon, E. S., and Ware, W. M.: The control of apple scab: Allington Pippin and Newton Wonder. 1933. *J. S.E. Agric. Coll.* 34, 136-144, 1934.

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57. EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE

Soil acidity.—The investigation which has been in progress for about six years on the variations in soil acidity is still being continued with a view to completing the study of the various factors concerned. The results which have been obtained show that the seasonal fluctuations are associated with climatic factors and plant growth (2) and that the composition of the soil solution is probably more important than its concentration.

An investigation has been carried out, under laboratory conditions, on the effect of various fertilisers on soil acidity. The results show (5) that, with the exception of basic slag, the changes which are likely to take place under field conditions due to the normal applications of the common fertilisers containing calcium, are extremely small. The action of basic slag in reducing soil acidity depends upon the type of slag and the character of the soil and, generally speaking, the effect is much less than that of calcium carbonate.

Soil fertility.—The work which has been carried out for two or three years on the *Aspergillus niger* method of estimating soil fertility is being continued for the purpose of arriving at satisfactory limiting values in the interpretation of the results (6, 7). In connection with the International Society of Soil Science scheme of co-operative work on the assessment of rapid laboratory methods of estimating soil fertility, between 140 and 150 special soil samples have been received for examination.

Potatoes.—Progress in the study of the identification of potato varieties by means of chemical tests is still being held up on account of the pressure of other work. It has been possible, however, to continue the experiments on the storage of new potatoes (3).

Oats.—Reference has been made in previous reports to the investigation which has been proceeding on the effect of nitrogenous top dressings on the composition of oats. A paper has been published (4), in which it is demonstrated that the protein content of the grain is increased, by merely delaying the dressing of nitrogeneous fertiliser, to an extent which makes it well worth the consideration of the grower. Even at the present low value of protein equivalent, the increase represents a gain of approximately 10s. per ton on the food value of the oats.

Silage.—The Department is taking part in an investigation into the composition of various types of silage made experimentally by the A.I.V. process at Boghall. The analytical work involved is complicated and laborious, but the results should be a useful contribution to a subject about which too little is known in this country.

Hardness of milk curd.—The experiments on the hardness of milk curd have been continued with special reference to the effect of different coagulants on the character of the curd (8). Owing to a defect in the apparatus, which had to be sent to America for repairs, the work has been interrupted.

Composition of milk.—The work in connection with the composition of milk from the pedigree herd of dairy cattle at the farm of the Institute of Animal Genetics (University of Edinburgh) at Shothead, Balerno, is being continued. In addition to the constituents formerly investigated, the chlorine-lactose ratio is now being determined. The results of the freezing point determinations have been communicated to the Society of Public Analysts who are making a critical examination of the usefulness of this method in analytical work.

Composition of heather.—The investigation into the composition of heather is being continued. The samples taken this season are now being analysed and the results obtained during the whole course of the experiment will then be collated.

Composition of pastures.—An experiment on the effect of nitrogeneous manuring on the composition of pastures is being carried out in conjunction with a commercial research station. The plots are dressed with varying amounts of ammonium sulphate and cut as nearly as possible once a month. The yield and percentage of dry matter is determined by the Department and the samples are then sent to the commercial station for more detailed analysis.

The investigation on the composition of pasture is still in progress. The analysis of last year's samples has now been completed and the results are being prepared for publication.

Poultry manure.—At the request of the Department of Agriculture of Scotland, this Department is taking part, in conjunction with the Rowett Institute and the other Scottish Colleges, in an investigation as to the production and composition of poultry manure. The experiments are being carried out at Boghall. It is hoped that by this time next year there will be sufficient data available to enable an approximate estimate of the value of the manurial residue of the food fed to poultry to be made.

Titles of papers issued during the year.

1. Smith, A. M.: Methods of estimating soil fertility. *Actes 2me. Conf. Intern. Engrais Chimiques, Rome*, 153, 1933.
2. ———: The variation in soil acidity. *Trans. 2nd Comm. I.S.S.S.*, A, 107, 1933.
3. ———: The storage of new potatoes. *Scott. J. Agric.*, **17**, 202, 1934.
4. ———: The increase in the protein content of oats obtained by delaying the application of nitrogen. *Ibid.*, **17**, 404, 1934.
5. Lauder, A., and Smith, A. M.: Observations of the effect of various fertilisers on soil acidity. *Agric. Prog.*, **11**, 93, 1934.
6. Smith, A. M., and Dryburgh, A.: A study of the technique of the *Aspergillus niger* method of estimating soil fertility. *Proc. 4th Comm. I.S.S.S.*, 1933.
7. ———: The examination of soils by means of *Aspergillus niger. J. Soc. Chem. Ind.*, **53**, 250T, 1934.
8. Lauder, A., McGillivray, J., and Comrie, A.: An improvement in the method for determining the hardness of curd from milk. *Agric. Prog.*, **11**, 121, 1934.

58. GLASGOW: WEST OF SCOTLAND AGRICULTURAL COLLEGE

Fertilisers.—The field trials to test the relative values of basic slags have been conducted at four centres in the College area. A thorough examination of the soils at each centre was made before the fertilisers were applied and it is hoped to follow up the trials with further examination of the soil after the crop has been lifted.

The estimation of available potash in soil has received attention and a rapid method for measuring it has been evolved. The method is being tried out to ascertain if it is suitable for advisory work.

The response to phosphates is being studied in association with a laboratory estimation of available phosphate.

Work upon the influence of lime and phosphate upon grass land and the relative advantages of varying the date of application is in progress.

Ripening of cheese.—A start has been made during the summer months to study the chemical changes associated with the ripening of cheese.

Poultry manure.—Experiments to test the residual value of poultry manure are in progress.

ENTOMOLOGY

59. ABERYSTWYTH: UNIVERSITY COLLEGE OF WALES

Winter spraying trials.—The study of the effect of winter washes on fruit trees with special reference to the mild moist weather conditions prevailing on the western seaboard has been continued, and washes produced in the Province tested against other and better known proprietary washes.

Virus diseases of potatoes.—Further work on the comparative resistance to virus diseases of various varietal strains of potatoes has resulted in the isolation of comparatively resistant strains. The seed produced from the resistant strains will be made the subject of further tests.

Control of turnip flea beetles.—Additional evidence has been accumulated to prove that derris dusts under certain conditions, provide an effective and economic remedy for the control of turnip flea beetles.

Potato eelworm.—The serious nature of the attacks of potato eelworm in the Province allowed of the carrying out of experiments on the effect of various chemicals, particularly of the naphthalene type, as a measure of control. The experiments were conducted at six centres, but in no case could it be found that the treatment was of any value, in one case it was definitely injurious.

Grass disease of horses.—The special investigation on grass disease of horses was continued throughout the year. An extensive survey of the insect population of infective and non-infective pastures in South Cardiganshire and Pembrokeshire has been made. The survey has now been discontinued and the results of the survey written up with a view to publication. Although perhaps valueless as a contribution to our knowledge of grass disease in horses, if the claims of the research workers of the Edinburgh University are correct, the survey is a valuable addition to our knowledge of the insect population of certain pastures in the Province.

Cestodes of birds.—The survey of the cestodes of birds has been continued and good progress has been made with the collection and identification of these parasites.

Minor investigations.—A preliminary investigation of the effects of extracts of nasturtium as a possible means of control of woolly aphis has been carried out. Extracts of the root, stems and leaves, were obtained and tested. This work is being continued. An additional investigation, in collaboration with Rothamsted Experimental Station, into the distribution and biology of certain cecidomyid midges in West Wales has been commenced.

A survey of the relative incidence of species of *Apion* on red clover, paying particular attention to the moult stages and growth rates, method of egg laying, and general biology of *Apion trifolii* has been made.

Cahn Hill survey.—A complete survey of the Cahn Hill estate, which varies in height from 1,200-1,600 feet above sea level is being commenced. It is proposed to make a complete general zoological survey including :—

(i) A detailed helminthological survey of the farm stock, attention to life history being paid where indicated.

(ii) An investigation of the connections between starlings and gapes, and the crop contents of wild birds.

(iii) A detailed entomological survey of soil forms and of herbage species, particular attention being paid to the Diptera in the latter case. Attention will be paid to all the pests of cultivated crops.

60. BANGOR: UNIVERSITY COLLEGE OF NORTH WALES

Blowfly investigations.—This work has been carried out conjointly with Dr. R. P. Hobson (see page 324). The main study has concerned the relationship of humidity to sheep maggot attack. The very high degree of susceptibility of young larvae of *Lucilia sericata* to dry conditions (less than 70 per cent. relative humidity) was demonstrated. Critical studies on the humidity of the fleece under varying weather conditions showed that, normally, the base of the wool is too dry (40-65 per cent.) for the development of young larvae. Some factor, urine or faeces in the breech, and, possibly, excessive sweating on the back, provides the necessary degree of humidity. Following washing, a high humidity (85-100 per cent.) was maintained for 22 hours. Lambs were sheared in order to produce a drier wool base, and, although the infestation during experimental period was low, the results indicated that shearing renders lambs less liable to attack.

Collembola.—Facilities were provided for a period of study at the Manchester Museum, when the Adviser had the opportunity of examining the Collembolan collections, and considerable advance was made in the systematic study of this order. A comprehensive collection of British species of Collembola has been prepared and two systematic papers have been published (3, 4). Further identifications have been carried out for entomologists in this country, and, in addition, collections from the S.S. "Discovery" Expedition to the Antarctic and the Percy Sladen Expedition to the Gulf of Guinea have been examined and identified.

Titles of papers issued during the year.

1. Davies, W. M.: The sheep blow-fly problem in North Wales. *Ann. Appl. Biol.*, **21**, 2, 267-282, 1934.
2. ———: Studies on aphides infesting the potato crop. II. Aphis survey: Its bearing in the selection of seed potato centres. *Ibid.*, **21**, 2, 283-299, 1934.
3. ———: Additions to the British list of Collembola with records of some rare species. *Ent. Mon. Mag.*, 99-94, April, 1934.
4. ———: The Collembola of North Wales. I. *N.W. Naturalist*, 116-124. June, 1934.

61. BRISTOL UNIVERSITY

The behaviour and control of the eelworm Heterodera schachtii.—Extensive field trials chiefly concerned control by means of dressings of calcium cyanamide and formaldehyde and yielded hopeful results, especially the former. No further host plants were discovered.

Control of flea beetles.—Further extensive field trials with a special seed dressing were undertaken chiefly on kale and swedes. The attacks by these pests were phenomenal, but the excessive heat and drought seriously interfered with results. Nevertheless the dressings afforded considerable protection from attack and further trials are contemplated.

The asparagus miner (Melanagromyza simplex).—Further investigations, in collaboration with Rothamsted Experimental Station, completed the main facts of distribution and life history, and a conjoint account was published (3).

Survey of the insect pests and diseases of hops in the Bristol Province.—This work was continued and reached a stage where it is felt that a sufficiently accurate knowledge has been gained to enable definite control measures to be attempted.

Titles of papers issued during the year.

1. Walton, C. L., and Kearns, H. G. H.: Experiments on the control of the chrysanthemum eelworm (*Aphelenchoides ritzema-bosi* Schwartz). Seasons 1931-32. *Ann. Rep. Long Ashton Res. Sta.*, 66-73, 1933.
2. Walton, C. L., Ogilvie, L., and Mulligan, B. O.: Observation on the pea strain of the eelworm *Heterodera schachtii* and its relation to " pea sickness ". *Ibid.*, 74-85, 1933.
3. Walton, C. L., and Barnes, H. F.: The asparagus miner, *Melanagromyza simplex* Loew. (Diptera: Agromyzidae). *Ent. Mon. Mag.*, **70**, 183-185, 1934.
4. Walton, C. L.: The pigmy mangold beetle. *Worcs. C.C. Agric. Quart. Chron.*, **2**, 1, November, 1933.
5. ———: The mangold fly (*Pegomyia hyoscyami*). *Ibid.*, **2**, 2, February, 1934.
6. ———: The swede midge (*Contarinia nasturtii*). *Ibid.*, **2**, 3, May, 1934.
7. ———: The cabbage white fly (*Aleurodes brassicae*). *Ibid.*, **2**, 4, August, 1934.

62. CAMBRIDGE UNIVERSITY

Wheat bulb fly (*Leptohylemia coarctata*).—An experiment to test the effect of rotations on this pest yielded no result owing to an insufficiency of attack on the control plots.

Flea beetles.—The attack of flea beetles was again very severe, but a very satisfactory control was obtained at three centres in Bedfordshire by means of timely applications of derris dust.

Apple blossom weevil (*Anthonomus pomorum*).—Experiments at three centres were started but yielded no result owing to an insufficiency of attack on the control plots.

Experiments with combined washes.—Experiments against apple sawfly and apple scab were carried out at two centres—one in Cambridgeshire and one in West Norfolk. Both sets of experiments showed satisfactory control of the sawfly, but owing to the small amount of apple scab present no figures on this were taken. No scorch was noticed as a result of the application of the combined washes.

Control of plum sawfly (*Hoplocampa flava*).—Spraying with nicotine sulphate, lead arsenate and lime sulphur, plus a spreader about a week after petal fall and again about a week later, gave a marked reduction in the number of plums damaged. Unfortunately this mixture caused many of the leaves to fall earlier and reduced the crop. Nicotine sulphate and a spreader gave a fairly good control, as also did derris and a spreader (1).

Cabbage aphis (*Brevicoryne brassicae*).—The life history shows that this pest is caused through the winter by eggs, chiefly on seed plants and broccoli. Experiments showed that the aphis which hatch in the spring on these plants can be controlled by spraying and very much reduced by dusting. Experiments during the summer show that it is difficult to control this pest by dusting once it is well established.

Work has been continued on the dipterous larvae infesting cereals and grasses (2, 3).

Titles of papers issued during the year.

1. Petherbridge, F. R., Thomas, I., and Hey, G. L.: On the biology of the plum sawfly, *Hoplocampa flava*, L., with notes on control experiments. *Ann. Appl. Biol.*, **20**, 429, 1933.
2. Thomas, I.: On the bionomics and structure of some dipterous larvae infesting cereals and grasses. I. *Opomyza florum*, Fabv. *Ibid.*, **20**, 707, 1933.
3. ————: On the bionomics and structure of some dipterous larvae infesting cereals and grasses. II. *Opomyza Germinationis*, L. *Ibid.*, **21**, 519, 1934.
4. Petherbridge, F. R.: Dusting for pest and disease control in the United States and Canada. *J. Min. Agric.*, 40, 209, 1933.

63. CARDIFF: UNIVERSITY COLLEGE OF SOUTH WALES

Warble fly control.—Further observations were made on a number of occasions to determine if possible, which particular flies are responsible for " gadding " in cattle—whether in addition to the adult warble flies the blood sucking tabanids would also cause the cattle to gallop. As last year *Tabanus bovinus* and *T. sudeticus*, the large " gad " flies, appeared relatively scarce in the area. The smaller flies *Haematopota sp.* were again seen on cattle, often in large numbers without appearing to disturb the animals much, but it is considered that where these flies are particularly numerous one of the cattle may become restive and may " gad ", the rest then following suit. On some such occasions the observer was unable to attribute this galloping to any other cause.

Root knot eelworm.—This pest was very troublesome at two centres in the province and tests were made of naphthalene and of carbon bisulphide emulsion. The emulsion was made up of 68 per cent. carbon bisulphide, 26 per cent. water and 6 per cent. resin-fish oil soap, as a stock solution. This was diluted 1 part in 50 of water before application and applied at the rate of 1 gallon per square foot.

This application was made on 6th February, 1934, and tomatoes planted out a fortnight later. During the season the treated plants appeared rather more flourishing than the untreated ones. The plant roots were examined on 13th September. On the treated plot all the plants had a mass of fibrous roots although some " root knot " was present. On the untreated plot, fibrous roots were practically absent, and the " root knot " condition very extensive.

Trials of naphthalene and the use of boiling water on other plots gave little result. The naphthalene plot showed no improvement over the untreated. The plot which had been soaked in boiling water appeared somewhat better but the amount of control obtained was not satisfactory.

In one house the soil was dug out to a depth of 1 foot and replaced with fresh soil but all the plants showed extensive " clubbing " of the roots when they were lifted.

A new grassland pest.—An investigation was made of the grassland pest recorded last year as causing extensive injury at two centres, and to a lesser extent at several other centres. Attempts to rear the caterpillars during the winter failed although several were induced to pupate normally. Examinations of the affected fields were made during the spring but no healthy pupae could be found and no moth likely to be the adult of this pest was observed there during the summer. The insect concerned is believed to be a migratory species *Nomophila noctuella* which visits this country each year, usually in relatively small numbers.

Wireworm control.—A field trial of naphthalene as a means of preventing wireworm injury to potatoes was made near Bridgend. Dressings at the rate of about 2 cwt. per acre were made in the row under the dung before planting. The potatoes were examined after lifting and there was markedly less injury to the tubers on the treated plot hardly any of them being holed, whereas on the untreated part of the field at least half of the tubers showed signs of some wireworm injury.

Yellow ants on pasture land.—A field test of granular calcium cyanide for the control of yellow ants was put down at St. Nicholas, Glamorgan. Each ant-hill was opened up by means of a crowbar and about 1 oz. of cyanide inserted, the hole then being blocked. A satisfactory control was obtained.

Colorado beetle survey.—In view of the danger of possible entry of the Colorado beetle via the South Wales ports, a survey of potato plots within a 1½ mile radius of the docks in the various ports was made in conjunction with the Ministry's Horticultural Inspectors in June. Suspicious injury was noted at one centre but was later attributed to earwigs.

Titles of papers issued during the year.

1. Thompson, H. W.: Plant pests of Glamorgan. II. *Trans. Cardiff Nat. Soc.*, **65**, 1934.
2. ———: The cockchafer beetle, its incidence and control in S. Wales. *Welsh J. Agric.*, **10**, 308-316, 1934.
3. ———: Common pests of farm and garden. *Western Mail Ann. Agric. Sup.*, February, 1934.

64. HARPER ADAMS AGRICULTURAL COLLEGE

Pigmy mangold beetle (*Atomaria linearis.*)—A full account of the field observations and experimental work on this pest over the past six years in the West Midland Province has been published (1). The only practical method at present known of exterminating the pigmy mangold beetle, once it becomes well established in areas devoted to sugar beet or mangolds, is by starving it out. This can be effected by keeping the ground free from sugar beet and allied crops for at least two years. In adopting this measure of control, it is essential to keep down the weed white goosefoot or fat hen which it is suggested is a host plant. Where frequent cropping of infested land with sugar beet or mangold cannot be avoided, the following measures are recommended:—

(i) Encouragement of rapid growth by good preparation of the land, together with a generous application of a nitrogenous fertiliser in conjunction with farmyard manure or complete minerals.

(ii) Treatment of seed prior to sowing by immersion in a solution of 5 lb. magnesium sulphate and 1 lb. phenol in 10 gallons of water.

(iii) Thick seeding to compensate for seedlings destroyed by the beetles.

(iv) Consolidation of the soil by frequent rolling.

(v) Late thinning with due regard to climatic and soil conditions.

Chrysanthemum eelworm (*Aphelenchoides ritzema-bosi*).—No method of practical value for the eradication of this eelworm in infected chrysanthemum plants has been available, but in view of the results obtained in experiments carried out at the College during the past three years, it would appear that this pest can now be controlled by subjecting the chrysanthemum root stocks or stools in autumn to a hot water treatment (2). Before treatment the old stems are cut back to within six inches of the base, young shoots or cuttings removed and the soil carefully washed off the underground parts of the plant. The stools are then placed for a period of thirty minutes in water heated to and maintained at a constant temperature of 110° F. Care is exercised to ensure that the temperature throughout the tank is kept uniform during this period of immersion by means of stirring the water.

Immediately after the hot water treatment, the stools are cooled in clean water and planted with as little delay as possible in non-infected soil for the production of cuttings.

Titles of papers issued during the year.

1. Edwards, E. E., and Thompson, J. K.: On the pigmy mangold beetle (*Atomaria Linearis* Steph.) and methods for its control. *Ann. Appl. Biol.*, **21**, 2, 300-318, May, 1934.
2. ———: *J. Helminth.*, January, 1934.

65. LEEDS UNIVERSITY

Control of potato sickness (*Heterodera schachtii*).—The effect of treatment of soil deficient in potash and heavily infested with potato eelworm (*Heterodera schachtii*) was tried in plot experiments. The addition of potash alone increased the yield but the tubers, like those on the plots without potash, were below seed size, disfigured by common scab and the plants died off prematurely from severe potato sickness accompanied by heavy eelworm infestation. Treatment with mercuric chloride alone gave a higher yield than potash alone and the produce was of good ware size, free from common scab and there was a marked diminution in eelworm infestation. Treatment with mercuric chloride and potash had no greater effect on the eelworm infestation than mercuric chloride alone but there was a further very substantial increase in the yield and the produce again was excellent in size and appearance.

Strawberry eelworm (*Aphelenchoides fragariae*).—A trial was initiated in September, 1934, with the object of determining the real cause of a decline in the strawberry stocks in the Cottingham district of the East Riding of Yorkshire, where the strawberry industry has largely lapsed. Although strawberry eelworm was found to be prevalent there appears to be a deterioration in the stocks due partly to virus disease; symptoms of "yellow edge" being widespread. On one market garden three types of treatment of runners prior to planting were carried out, namely: Hot water treatment, treatment with white oil emulsion, and treatment with lime-sulphur.

In addition rigorous selection to weed out runners showing symptoms of virus disease was carried out and is to be continued. It is hoped that in the spring the trial will give some indication as to the real cause or causes of the serious decline of the once very flourishing strawberry cultivation in this area.

Hot water treatment of diseased lily-of-the-valley stocks.—An obscure root rot disease of imported lily-of-the-valley was investigated. The diseased condition was associated with a root infestation by *Anguillulina pratensis*, which was not, however, considered to be the primary parasite. Hot water treatment was successful in controlling the condition, which is capable of causing complete failure of the planted stocks.

66. MANCHESTER UNIVERSITY

Biology and control of fruit infesting sawflies.—Research on the control of apple sawfly has been going on since 1932 when it was shown that the egg during incubation burst through the tissue of the floor of the calyx cup and so could be reached by insecticidal sprays. During 1933 it was shown that two sprayings with a nicotine wash at petal-fall and just following petal-fall would give about 90 per cent. control. In 1934 a single spray applied at petal-fall only reduced infestation from 63 per cent. to 22 per cent. and this was found to be owing to the extended emergence period of the adults and a consequently long oviposition period. From this it is deduced that in cases of serious infestation two applications are advisable, and it is apparent that the egg and young larva can be reached during a period of 8-10 days, which should give growers ample time in which to perform the operation.

Preliminary experiments on the control of plum sawfly showed that promising results followed two applications of a spray containing nicotine 8 oz. to 100 gallons at petal-fall and 4 days later. In the case of damsons infestation was reduced by 75 per cent.

Control of Scutigerella immaculata in glasshouses.—Experiments were carried out in the Blackpool district of Lancashire in which carbon bisulphide emulsion was used in an endeavour to control this injurious species. Pre-cropping treatment of 1 gallon per square yard of the emulsion diluted to 1/60 to the subsoil when trenching, followed by a surface application of 2 gallons per square yard of 1/100 solution, gave excellent results, effectively destroying the animals and having no injurious residual effect on the plants.

Control of turnip flea beetle by dusting.—Three applications of a naphthalene colloidal silica dust were found to give adequate protection to brassica seedlings against attack by flea beetles. The first application was made just when the seedlings were breaking through the soil, and the second and third at four day intervals.

Title of paper issued during the year.

Miles, H. W., and Miles, M.: Studies of the willow shoot moth (*Depressaria conterminella* Zell). *Bull. Entom. Res.*, 25, 47, 1934.

67. MIDLAND AGRICULTURAL COLLEGE

Bird problems.

Rooks.—During the survey of rooks in the Midland Province it had appeared that there might be a greater concentration of the birds on the Northamptonshire Sand Geological Formation. It was found possible during the Spring of 1934 to make a survey of the rookeries of the Soke of Peterborough. The following data briefly record the results :—

Area	98 square miles.	53·248 acres.
Ratio of grass to arable	3 : 4.	
Number of rookeries	33.	
Number of nests	1,666.	
Number of birds	3,332.	
Number of birds per square mile ...	34.	

One bird to nineteen acres.

As a result of the whole surveys there is no evidence of a direct influence by geological formations.

During the year further experiments have been made on the feeding of tame rooks in order to obtain the weight and volume of food consumed by them.

Other birds.—Endeavours have been made to study the damage done by larks to wheat and other cereals and to devise control measures. The damage caused by birds to buds and flowers has been under study.

Agricultural meteorology and phenology.—Assistance has been given in making observations during the year and a study of the winter flowering shrubs has been made. Hazel and *Prunus pissardi* are being propagated for use at various centres.

Cheese pests.—More experience has been obtained during the year of the good effects of fumigation with ammonia against cheese mite. Cheese fly has been a serious pest during the last two seasons in the Stilton factories. Experiments have been made on its control.

Soil pests.

Carrot fly.—Field experiments were laid down on a farm at Scotton in Lindsey. The material used was green tar oil absorbed in North African phosphate. This year the strength was doubled (2 per cent.). Unfortunately for the experiment the flies were again remarkably scarce. In gardens where the flies appear to be regularly found the method used produced good control.

Potato eelworm.—On an allotment in Leicestershire *Poa trivialis* has been sown with a view to testing whether this crop will produce a marked and rapid reduction of the cysts present in the soil.

Wireworms.—More trials have been made with a *dichlorbenzene* soil fumigant. The dressing was applied at the rate of 2 cwt. per acre on three fields, two in Lindsey and one in Nottinghamshire. On one field (Lindsey) the substance was broadcasted and harrowed in. The weather became wet. There appeared to be no effect on the wireworms. On the other field in Lindsey the fumigant was ploughed in. The weather was dry and considerable numbers of dead wireworms were found. The fumigant was ploughed in on the Nottinghamshire field under rather wet conditions. Although there appeared to be fewer wireworms on the field about a month later, yet there were many present and they appeared to be as numerous as on the undressed portion. It is hoped to make more tests in the coming season.

A trapping method was successfully used in a tomato house in Leicestershire. The plants were threatened by large numbers of wireworms in the soil after the house had been planted. It was impossible to apply dressings. By sowing wheat between the tomato rows the wireworms were decoyed from the latter. They were then trapped by pieces of carrots and potatoes and taken from the soil. In a comparatively short time about 12,000 wireworms were removed from this house (78 feet by 15 feet) and no plants were injured.

By means of pot experiments efforts were made to find the effect of wireworms on particular crops in order to be able to recommend the kind of crop to be sown on land known to be heavily infected. In addition to mustard, peas and beans appear to be able to withstand attacks remarkably well.

Millipedes.—Many tests have been made against these pests. The use of a proprietary fumigant on a field scale has not met with satisfactory results, although it appeared to be good in pots. An emulsion of carbon disulphide and naphthalene, and paris green-bran mash have both given promising results in small tests. It is hoped to continue experiments against these pests.

Other pests.—Experiments have been made against the apple capsid, using both nicotine and petroleum washes. Field tests were made against *Sitona lineatus* and also against turnip flea beetles.

Titles of papers issued during the year.

1. Roebuck, A.: *Trochilium apiforme* as a pest on poplars. *Ent. Mag.*, **70**, 95, April, 1934.
2. ————: Starling roosts in the Midlands. *British Birds*, **27**, 11, April, 1934.
3. ————: Bird problems in Lincolnshire. *Trans. Lincs. Nat. U.*, 1933.
4. Roebuck, A., Cranfield, H. T., and Stafford, J. G. W.: The control of cheese mites. *J. Min. Agric.*, **41**, 4, 347-352, July, 1934.
5. Roebuck, A.: The bird and animal pests recorded in the Midland Province. *Bull.* 30, *Midland Agric. Coll.*, 1934.
6. ————: Insect and allied pests recorded in the Midland Province. *Bull.* 32, *Midland Agric. Coll.*, 1934.

68. NEWCASTLE: ARMSTRONG COLLEGE, DURHAM UNIVERSITY

Turnip flea beetle.—Observations were made on the practical methods adopted by farmers against turnip flea beetle (*Phyllotreta undulata*) in the north. On many farms nothing is done against the pest, while others try various remedies. Of these the most successful recorded for 1934 were the use of paraffin as a repellant, and on two farms a heavy dressing of quicklime broadcasted on infested fields gave good results. Extra seeding on one farm proved useful.

Potato eelworm.—Trials with sulphate of potash were made against the eelworm *Heterodera schachtii* in potato plots on an allotment where Sharpe's Express and Duke of York potatoes were grown. Heavy and light dressings apparently helped on the crops, though there was no evidence of any diminution in the population of the eelworm in these plots.

Raspberry beetle.—Following upon preliminary trials with barium silico fluoride against the raspberry beetle (*Byturus tomentosus*) carried out in 1933, more extensive trials of this substance along with derris (in liquid and dust form), and nicotine were arranged for 1934. The results showed that while all the treatments gave a satisfactory control, liquid barium silico fluoride and liquid derris were more efficient than the same substances applied in dust form, and that applications made before the buds were fully opened appeared unnecessary.

69. READING UNIVERSITY

Strawberry pests (1, 2, 5).—Field investigations have continued. Dusting against strawberry blossom weevil gave very poor results, and other lines of attack are being explored. The hot water treating programme expanded and the process has now reached a stage at which it is being adopted by growers. A start has been made with a critical investigation of the role played by strawberry eelworm, and results of importance may be anticipated here shortly. The numerous other aspects of the strawberry problem remain under investigation.

Yellow stripe in narcissus.—Work upon this problem, which is apparently of a " virus " nature, has continued. No evidence has been obtained to support the hypothesis that thrip may be a vector, but a comprehensive series of experiments laid down in 1934 should provide valuable information in Spring, 1935.

Bulb scale mite in narcissus (7).—Investigations reported previously have now been abandoned and the results published. It is established that the pest is a very serious trouble, and that it is adequately controlled by means of hot water treatment as used against eelworm.

Stem and bulb eelworm (4).—Studies of the biology of this worm continue. During the year an account of the investigations into the incidence of attacks in English iris has been published, and special attention is now being paid to the serious inroads which the pest is making upon phlox.

Potato eelworm (6).—Field investigations in regard to this pest are in progress in Dorset and in Reading : the host range of various strains from localities within the province are being explored.

Lily pests.—Promising results have attended preliminary experiments with fumigants employed on a routine basis for the eradication of various serious pests.

Titles of papers issued during the year.

1. Hodson, W. E. H.: Pests in strawberry plantations, their elimination by the hot water system. *Fruitgrower*, **76**, Sept., 1933.
2. ———: Hot water treatment for strawberry mite. *Estate Mag.*, **33**, 12, Dec., 1933.
3. ———: The control of chrysanthemum eelworm. *H.E.A. Yr. Bk.*, **2**, 1933.
4. ———: *Anguillulina dipsaci* (Kühn) as a pest of bulbous irises. *J. Helminth.*, **12**, I, Jan., 1934.
5. ———: The control of strawberry pests by hot water treatment of runners. *J. Min. Agric.*, **40**, 12, March, 1934.
6. ———: Eelworms in potatoes. *Estate Mag.*, **34**, 4, April, 1934.
7. ———: The bionomics of the bulb scale mite, *Tarsonemus approximatus*, Banks, var. *narcissi*, Ewing. *Bull. Ent. Res.*, **25**, 2, July, 1934.

70. SEALE-HAYNE AGRICULTURAL COLLEGE

Bulb eelworm (*Anguillulina dipsaci*).—A method has been devised of measuring the temperatures actually reached in the interior of bulbs undergoing hot-water treatment, by the use of fine thermocouples mounted in hollow needles and stuck into the bulbs. This method has been used to study the heating of bulbs in commercial-scale baths. It has been found that during a standard heating of three hours to 110° F. many of the bulbs never reach this temperature, owing to the bad circulation of water in the bath. When the bulbs are left to " cool slowly " in sacks, this period of cooling actually provides a considerable additional period of heat treatment: this practice has unwittingly increased the efficiency of the control of eelworm.

Experiments were also carried out on the time of heating necessary to kill the eelworms themselves, particularly the desiccated worms often found on the outside of badly infected bulbs. These are more highly resistant than active eelworms, requiring as long as 78 minutes. As desiccated eelworms only occur on the outside of the bulbs, the question arises only in short-period treatment.

It was also found that weak solutions of iodine or formalin at 110° F. killed eelworms much more rapidly than water alone, and the addition of these chemicals to the water used in bulb baths should be commercially valuable.

Hot-water treatment of iris bulbs.—Bulb eelworm is infecting iris bulbs increasingly, and commerical hot-water treatment may soon be necessary. It has been found that one hour at 110° F. should be ample for the largest iris bulbs, assuming that the eelworm is not more resistant than the variety found in narcissus.

Iris bulbs heated to 110° F. for 50 minutes (a sufficient period for the size of bulb used) were planted, and found to be in no way harmed by the treatment.

Bulb scale mite (*Tarsonemus approximatus, var. narcissi*).

(i) *Hot-water treatment.*—It was found that the mites were actually killed by four minutes in water at 110° F. Bulbs (of the variety Golden Spur) were found to heat up to 110° F. in 23 minutes in water at that temperature: hence a treatment of 30 minutes is ample to kill all mites.

Healthy stocks of several varieties were treated in hot water for periods sufficient to kill *Tarsonemus*, and afterwards produced blooms of sufficiently good quality and quantity. The method appears to be commercially practicable, but the results are not yet conclusive enough to warrant definite recommendations.

(ii) *Cold-water treatment.*—Soaking of bulbs in cold water for three days will kill all *Tarsonemus* mites present, and as far as has been determined, all eggs also. Experiments on this method, and on its effect on the bulb, are in progress.

(iii) *Spraying.*—Oil sprays of the medicinal paraffin type will kill the mites exposed round the neck of the bulb, after the bulbs have grown. The drawback to this method is that most of the mites are inaccessible to the spray.

Bulb flies (Merodon equestris and Eumerus spp.)—The use of lime and cresote dust as a deterrent has been continued. The dust will keep flies away from narcissus for a period of five days only, so that at least six dustings would be necessary to cover the whole egg-laying period.

Violet eelworm (Aphelenchoides olesistus).—13 minutes at 110° F. is required to kill this eelworm. The time necessary to heat the runners through in water at that temperature is 1½-4 minutes according to size, giving a total treatment of 14½-17 minutes. Runners so treated will grow satisfactorily: but difficulties arise in the bulk treatment of runners.

Physiology of abnormal strawberry plants.—The effect of strawberry "red plants" on soil nitrogen has been confirmed, and this investigation (which is now primarily a soil problem) has been handed over to the Advisory Chemist.

Strawberry pests.—Runners placed in water at 110° F. were heated through in 1¾-5 minutes, the average time being 4½ minutes. Strawberry eelworm (*A. fragariae*), the most resistant pest, can be killed by 18 minutes at 110° F., so that a treatment of 19¾-23 minutes is required. The usual commercial period of treatment is 20 minutes, which is not quite enough. Runners heated for 25 minutes have grown satisfactorily.

Bulk treatment of strawberry and violet runners.—The electrical method of determining temperatures was applied to violet and strawberry runners treated in bulk in a commercial bath. It was clear that the effects produced by bulk treatment were erratic and unreliable, both as regards pest control and subsequent growth.

Chrysanthemum eelworm (Aphelenchoides ritzema-bosi).—The times necessary to kill this eelworm in water of varying temperatures are being determined. It appears to be more resistant than many other species.

Titles of papers issued during the year.

1. Staniland, L. N.: Entomological section. Tenth annual report. *Seale-Hayne Agric. College Pamph.* No. 42.
2. ———: The prospects for commercial violet growing. *Commercial Florist and Flower-grower.* November, 1933.
3. ———: Red spider attacks on violets. *Ibid.*, February, 1934.
4. ———: The violet aphis (*Myzus ornatus*). *Ibid.*, March, 1934.
5. ———: Violet eelworm. *Ibid.*, June, 1934.
6. ———: Bulb sterilising routine. *Ibid.*, August, 1934.
7. Goodey, T., and Staniland, L. N.: A dwarfing disease of cultivated violets associated with the eelworm (*Aphelenchoides olesistus*). *J. Helminth.*, January, 1934.
8. Staniland, L. N.: The loganberry cane maggot. *J. Min. Agric.*, **41**, 2, 151-153, May, 1934.

71. WYE: SOUTH-EASTERN AGRICULTURAL COLLEGE, LONDON UNIVERSITY

Control of the strawberry blossom weevil (*Anthonomous rubi* Herbst.).—Field and laboratory experiments have been continued. In the field, dusts containing rotenone were used exclusively but failed to give a satisfactory control and this failure, viewed in conjunction with results obtained in the insectary, leads to the conclusion that this insecticide is of little commercial use against the weevil. In the insectary, dusts containing rotenone, pyrethrum and barium silico-fluoride were used, without any satisfactory kill of the weevils being obtained.

The ovicidal action of various oil emulsions as winter washes.—This work has come to a natural conclusion along the lines originally planned. Tests were carried out in order to obtain confirmation or otherwise of results previously recorded, using the same technique as that adopted in former years. Field trials consisted of demonstrations on a commercial scale of the value of the home prepared oil emulsion against the eggs of the common green capsid bug, *Lygus pabulinus*, on red and black currants.

Pyrethrum.—The fifth crop has been harvested from the experimental half-acre plot. It proved to be about the same weight as that of 1933 and slightly better in content of the toxic pyrethrins. A series of plots, to study the effect on yield, longevity and habit of growth of plants put out at different distances of planting has been laid down. In addition, methods of vegetative propagation have been studied and valuable information obtained on this point.

Insect and allied pests of cultivated mushrooms.—Work on mushroom pests, which has included a systematic survey of the fauna of stable manure used for the purpose of preparing beds has been continued. Samples have been taken at various periods during the composting process from the outside and inside of heaps, corresponding approximately to places of maximum and minimum temperatures, which have been recorded at the time. This type of examination is being applied to as many heaps of manure as possible as well as to that obtained from various sources, with the object of discovering to what extent the actual pests of the crop may be introduced with the manure. A survey of the incidence of pests on commercial mushroom beds has also been made and the chief species involved are recorded.

Chalcid parasite (*Aphelinus mali*) *of the woolly aphis* (*Eriosoma lanigerum*) *in the field*.—This parasite successfully survived the winter and a series of routine spray applications and in the summer of 1934 was observed to be very active. It had clearly exerted an appreciable check upon the increase of woolly aphis although this pest was not ordinarily quite as abundant as in some seasons.

Control of the potato eelworm (Heterodera schachtii).—An experiment was laid down on allotments at New Romney where very poor potato crops have recently been obtained and where the eelworm was abundant. A number of plots were laid out on two allotments with the object of testing the effect of manurial treatments on the crop, as well as soil treatments for the control of the eelworm. Complete crop weights are not yet available but a visual impression of the plots suggests that the use of good seed alone, combined with suitable manure and fertilizers has done a great deal to improve the weight of crop obtained.

Control of wireworms.—Using the same proprietary soil insecticide as that employed for the trial reported in 1933, together with semi-refined naphthalene, a series of plots was put down at the Kent Farm Institute, Borden. A ley being ploughed for wheat was selected and plots each 1 chain square treated. Wireworm attack on the part of the field under treatment was small, but the plant on the whole field was very thin indeed and was cultivated up in the spring and barley sown. It was not possible to locate the plots by visual differences except in the case of one naphthalene treatment, on which the plant was much greener and thicker. The duplicate of this plot was, however, no better than the remainder of the field.

The proprietary soil fumigant was also used on land prepared for mangolds at Hever, Kent. It was applied about five weeks before drilling and dead wireworms were turned out and seen by the farmer during drilling. The treatment, however, had an obvious effect in inhibiting the germination of the seed to a large extent, resulting in a thin plant.

Control of the hop red spider mite (Tetranychus telarius).—Investigations were commenced to determine to what extent the mite survived the winter in crevices of hop holes. Poles from an infested piece of hops were removed, split and examined and over 5,000 hibernating female mites were found in one pole. The effect of soil treatment with naphthalene in the winter was studied, the dressing being forked in around selected blocks of hills. No material difference in the infestation between treated and untreated blocks could be observed in the summer. A number of substances were tried out as sprays during July and August against the mites, when infestations were becoming widespread. In a field trial at Chartham, Kent, lime-sulphur applications gave the best control but seemed to cause some slight leaf injury when applied during the latter half of July, on the variety Cobbs. Smaller scale trials carried out at the College with a number of other washes gave useful information as a basis for subsequent tests. In August, Fuggles, Cobbs and Early Birds in burr were sprayed with lime-sulphur. No injury whatever was apparent and normally seeded cones were produced. Five concentrations from 1 in 60 to 1 in 150 of lime-sulphur were used without injury. Young cones sprayed with 1 in 150 were injured.

Titles of papers issued during the year.

1. Austin, M. D., Jary, S. G., and Martin, H.: Studies on the ovicidal action of winter washes. *J. S.E. Agric. Coll.*, 34, 114-135, 1934.
2. Austin, M. D., and Jary, S. G.: Investigation on the insect and allied pests of cultivated mushrooms, II and III. *Ibid.*, 34, 70-86, 1934.
3. Jary, S. G.: Insect pests and the weather in 1933. *Ibid.*, 34, 65-69, 1934.
4. ———: A note on injury caused by two species of *Thysanoptera*. *Ibid.*, 34, 63-64, 1934.
5. Stapley, J. H.: The apple fruit miner (*Argyresthia conjugella* Zell.). *Ibid.*, 34, 87-92, 1934.

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72. ABERDEEN: NORTH OF SCOTLAND COLLEGE OF AGRICULTURE

Cabbage root fly.—The insect was as common as usual, attacking cabbage, cauliflower and some other cruciferous plants. The methods of control attempted last year for field crops of turnips and swedes did not give conclusive results. This year it was intended to experiment on control on a field scale with a mixture of ortho- and para-dichlorobenzene mixed with sand and broadcast by hand at the time of the first hoeing, but as the result of an accident the chemicals were delivered too late to be used on turnips. However, they were used on cabbage and cauliflower, and they seem promising in controlling the cabbage root fly and other soil insects.

Turnip flea beetle.—This pest caused much loss of turnips and swedes in 1934. Apparently only one species of insect was concerned in damaging the plants. Powdered asafoetida mixed with the seed seemed useless for control. Paraffin or turpentine mixed with the seed seemed ineffective in most cases A mixture of ortho- and para-dichlorobenzene mixed with sand and scattered along the rows of young plants seems promising as a repellent. It is intended to experiment next year with seed treatment on a number of farms.

Sheep maggot fly.—In conjunction with the Zoology Department, University of Aberdeen and the Rowett Research Institute the sheep maggot flies are being investigated with the intention of finding more satisfactory methods of control than those usually adopted at present.

Insecticides.—Various insecticides were tested for the control of whitefly, aphis, apple sucker, red spider, gooseberry sawfly and other insects.

Bee diseases.

Acarine infection.—This infection has been found in 15 counties in Scotland, 15 in England, 2 in Wales and 1 in North Ireland. Frow's mixture (2 parts nitrobenzene, 2 parts petrol, 1 part safrole) for the treatment of acarine disease has proved very satisfactory in a number of cases examined by the Department. The benefit of Frow's mixture lies in proper dosage, when it is able to kill the mites of all stages inside the tracheae of living bees. The mites may be exterminated in 10 days. Strictly speaking, Frow's mixture does not " cure " diseased bees, but it kills the mites inside them so that they do not pass on the infection to other bees. The recovery of the stock depends on good beekeeping, which provides for the establishment of a strong stock as soon as possible after the treatment.

Methyl salicylate has been used by many beekeepers for the treatment of acarine disease. It is liberated in the chamber containing the bees by various methods. One method of liberation is from a glass bottle provided with a large wick which allows the liquid to ooze up and vaporize in the atmosphere of the hive. Each hive is provided with one or more bottles filled with methyl salicylate. Another method of liberation is from a pad of absorbent material which is periodically soaked with the substance and placed inside the hive so that the fumes fill the chamber with the bees. The amount dosed should be sufficient to keep the atmosphere of the hive permeated with the smell of methyl salicylate for at least one month, and the smell should be easily noticeable outside the hive. The Department has not experimented with methyl salicylate during the last year, but it has examined bees from various infected stocks that were treated by different beekeepers with methyl salicylate, and the conclusion is that methyl salicylate may kill the mites inside living bees under certain conditions which are not properly known, and that the time required to exterminate the mites is at least one month.

Title of paper issued during the year.

Morison, G. D.: *Liogryllus bimaculatus* De Geer (Gryllidae) in Aberdeen. *Etom. Mthly. Mag.* **70**, 95, April, 1934.

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73. EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE

The investigations of the biting horse-flies (*Tabanidae*) were continued and extended. The results of the work on the cleg (*Haematopota pluvialis*) have been published. Several other closely allied species are now being dealt with and it is hoped finally to make a complete survey of the Scottish species. Recently *Tabanus fulvus*, *T. sudeticus*, *T. distinguendus*, *T. montanus* and *Chrysops relicta* have been induced to feed and oviposit in the laboratory and the immature stages of each of these are being reared.

Title of paper issued during the year.

Cameron, A. E.: The life history and structure of *Haematopota pluvialis*. Linné (Tabanidae). *Trans. Roy. Soc. Edin.*, **58**, I, 10, 1934.

MYCOLOGY AND BOTANY

74. ABERYSTWYTH: UNIVERSITY COLLEGE OF WALES

Bunt in wheat (*T. caries*).—Experiments on the control of bunt in wheat were continued and new methods of treatment tested against copper sulphate and formalin. The results of this trial, at present incomplete, indicate that with a heavily contaminated sample of wheat, dust treatments are not as efficient as copper sulphate or formalin.

Loose smut in wheat (*U. tritici*).—A number of pure lines of Hen Gymro wheat growing at the Welsh Plant Breeding Station showed considerabley smut infection last year. Seed is distributed to farmers every year and to ensure healthy stocks it was decided to treat each pure line with Jensens' hot water method with the object of controlling the disease. Each pure line was first of all soaked in cold water for four hours and then transferred to a hot water bath with a temperature of 52°-54°C. for ten minutes. The temperature of the bath remained stationary throughout the time limit. A sample of each pure line was taken before treatment to act as control. The treated and untreated seed was sown in drills. Germination and growth of all the lots were good and no difference in growth could be observed between treated and untreated rows. Complete control of loose smut was obtained in three pure lines of wheat, but only partial control in the fourth. The failure of the hot water in the fourth pure line is not clearly understood and further trials are in progress.

Smut in oats.—Smut diseases of oats have become so prevalent during the last two years that it was decided to carry out trials with the object of discovering the most satisfactory method of control. Experiments carried out at other stations show the possibility of doing so with mercuric dusts. Three proprietary brands of mercuric dusts were used on smutted seed of the varieties Ceirch-du-bach and Cierch Llwyd which are extensively grown in West Wales. Treated and untreated seed of both varieties were sown in alternative rows and replicated eight times. Later all the rows were harvested separately and examined for the presence of smut. Little difference in the degree of infection between the treated and untreated rows was observed.

With the exception of six panicles of covered smut (*U. Kolleri*) all the smut was of the loose type (*U. Avenae*). The failure of the mercuric dusts treatments to control smut in the two varieties of oats is significant.

Finger and toe in cauliflower.—Further trials were carried out with mercuric chloride on matured plants. Suitable plots were selected and planted with the variety Autumn Giant. One plot was left untreated, but in the other plot plants received ½ pint of mercuric chloride before they were planted. One hundred plants were put in each plot. The produce from each plot was sold and following amounts realised; treated plot £1 5s. 0d. (75 plants), untreated plot 8d. (2 plants).

The difference between the two plots is very striking. Plants in the untreated plot were so badly clubbed that only two of them produced saleable curds.

Mercuric chloride has given such consistently good results in our experiments that it can be recommended to growers as a satisfactory treatment against finger and toe.

Onion mildew (*P. schleideni*).—This disease continues to cause considerable trouble to small growers. Trials were therefore carried out at three cottage gardens on measures of control. Crops were sprayed with a colloidal solution of copper, the first spray being given during the third week in July and continued at fortnightly intervals, but a small portion of each crop was left untreated. The first application of the spraying mixture was given during a period of hot weather and although the crops were sprayed after sunset, considerable scorching of the foliage occurred. The result obtained shows very clearly that solutions of copper are not satisfactory against onion mildew, owing to severe scorching of the foliage.

Title of paper issued during the year.

Davies, D. W.: Control of American gooseberry mildew. *Brecon and Radnor Farmer's Gaz.*, **1**, 4, 1933.

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75. BANGOR: UNIVERSITY COLLEGE OF NORTH WALES

Potato virus diseases.

Streak.—Two forms of streak supplied by the Plant Registration Station, Corstorphine, have been kept under close observation for several years. They have proved to be non-infectious. The data accumulated have been handed over to the Station as a contribution to a more extensive study.

Over-wintering of leaf-roll.—Experiments designed to recover virus from brassicae on which *Myzus persicae* had been feeding had consistently given negative results, although the aphides remained active vectors. Joint work with the Advisory Entomologist was therefore arranged to ascertain the " virus condition " of alatae of this species during the Spring migration to potatoes. Out of 1,178 such aphides, collected at intervals in a district where degeneration of potatoes is rapid, in only four instances was there positive evidence of transmission of leaf-roll to healthy half-tubers. These four cases involved fifty alatae, but, in view of the negative results in the remaining 77 experiments it is believed that probably only four insects were active vectors. It is concluded that transmission, from crop to crop, in the field by alate *Myzus persicae* is extremely slight, but is sufficient to introduce disease into healthy stocks; the subsequent spread within the crop being mainly by means of apterae.

The value of " secondary growth " tubers for seed.—Replicated field trials have been carried out with the following four classes of tubers:—(i) large normal; (ii) large " primary " (similar to (i) but from which secondary growths were detached); (iii) small normal; (iv) small secondary tubers comparable in size to class (iii). The results showed that the small secondary tubers gave a significantly higher proportion of ware, and less virus infection than any of the other classes.

The economic importance of " carrier " plants.—An attempt is being made to assess the danger to a susceptible variety, of proximity to a " carrier " variety under field conditions—all opinions at present being based upon artificial inoculations or grafting under glass. To do this, stock seed of two carrier varieties were each planted, in eight replications, between three susceptible varieties. The latter were planted as half-tubers with the other halves planted elsewhere as controls. The whole trial was isolated in oats to minimise risk of extraneous infection. Only a few plants showed symptoms and these were at once removed. Aphides were abundant later, and ample opportunity was therefore afforded for the transmission of the " carried " viruses to susceptible plants. The crops from plants exposed to such infection and their controls will be grown in 1935 in properly replicated trials. It is expected that careful notes will show whether transmission did occur in 1934 and a comparison of yields should indicate the extent of any loss.

" Copper-strip " method of diagnosing degeneracy in tubers.—This work was repeated in 1934, using a modification of the German method. The results were the same as in previous trials in that no connection could be established between the symptoms induced by the copper and the absence of virus infection. The marked difference in reaction, however, is obviously of great physiological interest and is being followed up.

Diseases of crops other than potatoes.

Control of finger and toe.—Three separate pieces of work on the effects of mercuric perchloride as a means of controlling finger and toe in brassicae are in progress in co-operation with other Advisers. The efficacy of the compound is substantiated in the first of these, an account of which was published in the Ministry's Journal for July, 1934. The second shows that some little improvement in control in the seed-bed is effected by application of the chloride over the whole surface instead of restricting it to the drills. The third proves that no adverse effect on the root system of the brassicae is produced by application of the mercury compound.

Field trials of the effects of various dressings of lime on swedes, cabbages, cauliflowers and brussels sprouts, have been in progress, without rotation on contaminated land for two years. They will be continued another season before conclusions are drawn.

Diseases of swedes.—The effects of varying the distance at which swedes are singled on the incidence of mildew, *Cercospora* leaf-spot, *Phoma* dry rot, and bacterial crown-rots and root-rots, as well as the effect on cropping power have been studied.

" Brown heart " of swedes has been shown to be non-pathogenic and to be caused by malnutrition. Proof has been obtained in trials on four farms that a considerable degree of control is effected by the application of borax at the rate of 10 lb. per acre ; no increase of control is obtained by doubling the rate. The susceptibility to attack has been studied in some fourteen varieties of swede.

76. BRISTOL UNIVERSITY

Die-back of apple trees.—Further work has been done on die-back of apple trees in the Province and their relation to certain feebly parasitic fungi. A number of cases in Worcestershire have been kept under observation and the associated fungi have been isolated and tested for pathogenicity. No highly parasitic fungus has been isolated, but the feebly parasitic *Valsa ambiens* previously encountered has been found to be widespread.

Fruit spots and fruit rots.—Several of the fungi causing prevalent fruit rots have been inoculated on to healthy and burned twigs but most are able to persist and multiply only on dead twigs. Hence such twigs form an important source of fruit infection.

Strawberry root rots.—An investigation on strawberry root rots as they occur in the Province was carried out. Fungi identical with those isolated by Berkeley in a parallel series of investigations were obtained from root rots in the Province. A small number of the fungi appear to be actively parasitic, such as *Cylindrocarpon radicicola.*

Miscellaneous strawberry diseases.—A note was published (2) on a disease of strawberries prevalent in the Province which may be identical with the American " crinkle." In the disease in question there is a marked " clearing " of the veins, accompanied by mottling and transparent spots which dry out into reddish or purplish areas. Severely affected plants are much dwarfed and flattened.

Miscellaneous virus diseases of small fruits.—Stocks of seedlings of certain small fruits, such as raspberries, black currants, red currants, have been raised in insect-free conditions, and work on certain obscure virus diseases of these has been commenced.

Virus diseases of tree fruits.—Symptoms suggestive of Atanasoff's " Plum Pox " have been found to be prevalent and this and other possible virus diseases of tree fruits are being kept under observation.

Asparagus diseases.—Trials of various vegetables were laid down on areas in which asparagus had been affected with violet root rot (*Rhizoctonia Crocorum*). Beets, mangolds, parsnips, carrots and potatoes were attacked by the fungus. Dwarf beans and clover were immune.

Diseases of beans.—Among *Fusarium spp.* isolated from dwarf bean plants infested with foot rot, the *F. Solani* var. *Martii* group have been found to be the most pathogenic. Variety trials were laid down in the Evesham area and although no varieties were very markedly resistant several apparently resistant seedlings were marked and the seed of these was saved.

A new bacterial disease of runner beans is under investigation. This causes leaf spots with concentric markings and shot holes. Further work has been carried out on the species of *Fusarium* responsible for wilt of runner beans.

Lettuce diseases.—Fungicidal treatments were again ineffective against ring spot, but the varieties Arctic and MacHatties Giant were again found to be somewhat resistant.

Preliminary experiments indicated that mosaic is probably transmitted from plant to plant by the aphis *Macrosiphum sonchi.* This aphis occurs on sow thistle and groundsel, and on lettuces late in the autumn and early in the spring.

Mint rust.—The occidial stage of *Puccinia menthae* causes much damage to forced mint in the Province. Further trials have again shown that a late spraying of 5 per cent. tar oil prior to lifting, is of value. A collection of species and varieties of mint has been made and numerous seedlings have ben raised; some of these appear to be somewhat resistant to rust.

Pea sickness.—This condition, caused by the eelworm *Heterodera schachtii*, has been investigated in co-operation with the Advisory Entomologist (4). Further trials have shown that applications of calcium cyanamide and of formalin (2 per cent.) enable plants to produce a normal yield in infested soil.

Other vegetable diseases.—Among the diseases of vegetables on which work has been done are white rot of onions, spotted wilt of tomatoes, " finger and toe " of brassicae, soft rot of celery, mosaic of vegetable marrows and white tip of leeks.

Diseases of ornamental plants.—A root and stem rot of delphiniums associated with *Thielavia basicola* is being investigated. *Fusarium* wilt of asters and lily diseases have also been studied.

Willow rust.—Further field experiments on the control of the *triandra* rust (*Melampsora Amygdalinae*) were laid down but were inconclusive owing to the dry season. An article on willow diseases was prepared as an appendix to an economic survey of the willow industry (12).

Virus diseases of hops.—Little progress was made with this project since the hop seedlings raised under controlled conditions died off during the winter months.

Titles of papers issued during the year.

1. Ogilvie, L.: The effect of formalin on potato " sickness ". *Ann. Rep. Long Ashton Res. Sta.*, 86, 1933.
2. Ogilvie, L., Swarbrick, T., and Thompson, C. R.: A note on a strawberry disease resembling the American " crinkle ". *Ibid.*, 96, 1933.
3. Ogilvie, L., and Mulligan, B. O.: Progress report on vegetable diseases —V. *Ibid.*, 98, 1933.
4. Walton, C. L., Ogilvie, L., and Mulligan, B. O.: Observations on the pea strain of the eelworm *Heterodera schachtii. Ibid.*, 74, 1933.
5. Ogilvie, L., and Mulligan, B. O.: The fusarium wilt of china asters in England. *Gard. Chron.*, **95**, 2466, Mar. 31, 215, 1934.
6. Ogilvie, L.: Antirrhinum rust. (A Note.) *Ibid.*, Mar. 31, 217, 1934.
7. ———: The menace of the virus diseases of plants. *Herefordshire Agric. Quart. J.*, **2**, 2, 63, June, 1934.
8. Ogilvie, L., and Mulligan, B. O.: Vegetable diseases in Worcestershire—IV. Asparagus diseases. *Worcs. Agr. Quart. Chron.*, **2**, 1, Nov., 1933.
9. ———: Vegetable diseases in Worcestershire—V. Diseases of onions. *Ibid.*, **2**, 2, Feb., 1934.
10. ———: Vegetable diseases in Worcestershire—VI. Foot rot (dry root rot) of dwarf beans. *Ibid.*, **2**, 3, May, 1934.
11. ———: Vegetable diseases in Worcestershire—VII. Botrytis disease (collar rot) of winter lettuces. *Ibid.*, **2**, 4, Aug., 1934.
12. Ogilvie, L.: The diseases of basket willows in Somerset. Appendix to " An economic survey of the Somerset willow growing industry " by Dawe and Blundell. Bull. 9, *Dept. of Agric. and Hort., Bristol U.*, **81, 1933.**

77. CAMBRIDGE UNIVERSITY

Seed Disinfection.—Work has been continued in the field and in the laboratory on the development of new fungicides for seed treatment and the technique of this disinfection for agricultural and horticultural seeds. A wide range of inorganic and organic mercury compounds has been tested and certain of these salts have been effective as fungicides at very weak dilutions. From these, fungicidal dusts have been prepared which have been most effective in small field experiments in controlling seed-borne diseases. Apart from the lethal effect of these dusts on the known parasitic organisms that contaminate or infect the seed, it is thought that they may exert a further action by preserving from soil saprophytes the food supplies that are stored in the endosperm or the cotyledons of the seed.

" *Fire* " *in tulips.*—Both in the forcing house and in the field it was necessary to rogue out primary infections at an early date to obtain control of the disease. Dusting or spraying with a fungicide was of little value if the primary infections remained.

Asparagus rust.—Rust has been found in some 30 localities in the Province, with many severe attacks. Imported varieties, said to be immune, appear to be susceptible to rust in East Anglia. Dusting with sulphur did not control the disease, but good control was obtained by cutting the infected " bower " close to the ground before the needles fell and burning, and rogueing out the aecidial stage in the spring.

Early blight of potatoes.—This disease was rather more prevalent than in 1933 and the causal organism has been confirmed as *Alternaria Solani* (Ell. et Mart.) J. et Gr. Under laboratory conditions it does not spore easily unless kept in a high light intensity.

Blackening of the tips of chitted tubers.—As very slight bruising is one of the causes of this condition, trays and tubers must not be unduly shaken when handled.

Sugar beet diseases.—The principal trouble found was " blackleg " ; in some cases this was associated with the fungus *Phoma betae* and in other cases with acid soil condition and waterlogging. The " blackleg " condition can be circumvented by sowing " dressed " seed on sweet and well drained soil.

Mint rust.—Experiments to control this disease by rogueing the beds in the Spring proved abortive.

Silver leaf.—The spraying of dead wood bearing fructifications of the silver leaf fungus, to prevent spore dispersion, was valueless but flaming such wood with a painter's blow lamp was successful.

78. CARDIFF : UNIVERSITY COLLEGE OF SOUTH WALES

Sainfoin.—The vegetative propagation of some selected plants continued. The appearance of rust requires further observations in addition to those on susceptibility to other diseases. Different strains are studied from point of view of hardiness, persistency and yield.

Lucerne.—Observations on yield and hardiness similar to those of previous years have been continued.

Grasses and clovers.—The pedigree strains of some grasses have been maintained as well as the commercial and local strains of red and white clovers.

Soya bean.—The two selected strains have been carried on and observations have been made on the value of lawn cuttings as manure, and on the effect of the distance between the plants and drills. In the dry seasons of 1933 and 1934 lawn cuttings have been particularly beneficial.

81. MANCHESTER UNIVERSITY

Blackleg or stem canker of brassicae (*Phoma lingam*).—In a recent publication, a form of seed treatment has been mentioned as greatly reducing the incidence of this disease. Unfortunately, the treatment of seed in bulk by this method cannot be entertained by the seedsmen.

The alternative would appear to be the raising and maintaining of clean parent-stock-seed plants. A start has been made in this direction, on lines similar to those already adopted so successfully in the case of celery blight. Several methods are under trial.

Celery blight (*Septoria apii*).—The production of clean seed by regular and periodical spraying of the parent plants (themselves raised from clean seed) has been continued. Last year's production of this particular seed, by a local firm, has been greatly sought after by the large-scale commercial market growers, as the necessity for any special seed treatment by the purchaser is entirely eliminated.

Clubroot of brassicae (*Plasmodiophora brassicae*).—Co-operative experiments with five other Advisory Mycologists were undertaken. The local results have again proved the value of corrosive sublimate in (i) aiding the development of fine fibrous roots and (ii) eliminating the incidence of clubroot in the seedbed entirely, by not less than two applications of the solution. In conjunction with these experiments, a series of soil analyses have been carried out and an attempt made to find out the reaction of corrosive sublimate in the different soils, as no information on this subject is available.

Grey leaf in oats.—A top-dressing of manganese sulphate (at the rate of ½-cwt. per acre) on a badly affected crop of oats at one centre (aided by a good rainfall) gave an immediate and surprisingly favourable response. The crop grew and matured well, although during the early stages it had seemed almost a hopeless failure. Further experiments with other and cheaper materials are under trial.

Titles of papers issued during the year

1. Smith, E. Holmes: A playing fields fungus menace. *Gard. Chron.*, **95**, 333, 1934.
2. ————: Spotted wilt of tomato. *Ibid.*, **96**, 11, 1934.
3. ————: Internal brown fleck of potato. *Ibid.*, **96**, 178-179, 1934.

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82. MIDLAND AGRICULTURAL COLLEGE

Soil sterilization in glasshouses.—Experiments on soil sterilization, using 2 per cent. formalin at the rate of 5-7 gallons per square yard, have been continued. This treatment gave good control of " sleepy " disease in tomatoes and also increased the vigour of the plants, resulting in larger crops. Further work shows that it is unnecessary to cover the soil with sacking for a few days after the application of formalin and if chrysanthemum cuttings and young, tender seedlings (such as lettuce) are planted in soil treated with formalin before it has become "sweet," they are killed. Tomato plants, at the stage of growth when they are ready to be planted into their permanent quarters, are not killed if planted in soil containing formalin fumes, but they show no signs of growth for 2-3 weeks. It is recommended, therefore, that before tomato plants are set out in formalin treated soil, the soil should be forked regularly for 10 to 14 days after the treatment.

Effect of mercuric chloride on the formation of fibrous roots.—In co-operation with other advisory officers in different parts of the country, an experiment was carried out to determine the effect of mercuric chloride on the formation of fibrous roots in cauliflowers, apart from its action on the finger and toe fungus. At the end of the season, there was very much less fibrous root on plants that were treated with mercuric chloride at the beginning of the season than on those not so treated.

Potato blight.—Spraying experiments were carried out using a proprietary colloidal copper compound and also a proprietary copper dust. Blight did not appear in the potato crop and therefore no observations could be made on the efficiency of these two preparations in controlling the disease. The colloidal copper compound left only a faint sheen on the leaves of the sprayed plants, and these plants remained green longer and gave a heavier crop than the unsprayed plants. The haulms of the plants treated with the copper dust died down fairly soon.

Experiments to prevent potato scab.—No control of common scab in potatoes was obtained by using dressings of mercurous chloride to the soil.

83. NEWCASTLE: ARMSTRONG COLLEGE, DURHAM UNIVERSITY

Fusarium spp. on British cereals.—The object of this investigation is to ascertain what species of *Fusarium* occur on our cereals and what harm they do. In addition a definite plan of simple cultural work is recorded, with appropriate illustrations, to facilitate identification by general mycologists. A further nine species have been dealt with on these lines. The detailed paper is being completed for publication.

Diseases of turf of bowling and golf greens.—The examination of turf from other districts, Kent to Aberdeen, has shown *Fusarium nivale* to be the most common disease organism. At certain times of the year *Corticium fuciforme* predominates, and studies of this organism have been made. The investigation concerns its reaction to acidity, temperature, and various chemical substances likely to be of use for control of the disease; the pathogenicity toward turf grasses has also been dealt with experimentally. The application of fungicides has been continued under practical conditions on four bowling greens and on selected greens and fairways of a golf course.

84. READING UNIVERSITY

Canker and dry rot diseases of swedes.—The lengthy investigations on these diseases caused by the fungus *Phoma Lingam* were concluded by the publication of the results obtained and a general review of the problems (1).

Bunt in wheat.—Strikingly good results were obtained both in the laboratory garden, and in plots at the University Farm, from the use of red oxide of copper (cuprous oxide) as a " dust " on badly contaminated samples of seed.

Phytophthora diseases of tulips.—The series of experiments on the diseases of tulips caused by *Phytophthora erythroseptica* and by *Ph. cryptogea*, one phase of which is known by the practical forcer as " Shanking ", was brought to a conclusion during the season, and the writing up of the results is in hand. Numerous cases of losses due to these diseases continue to come to notice, and the experimental work is proving of great value in giving practical advice.

Other diseases of tulips.—Minor experimental work has been commenced with the grey bulb rot disease (*Sclerotium Tuliparum*), and the *Pythium* disease of tulips, but intensive investigation of the latter is held up until the provision of an adequately heated glasshouse is possible.

Penicillium disease of bulbous iris.—Extensive losses on large nurseries forcing hundreds of thousands of iris have been found to be due to *Penicillium sp.*, and experiments have been started on a comparatively large scale in an endeavour to throw light on the problem. The prevention of wounds by rough handling in lifting, sorting and storing, and the humidity of the storage places seem to be important factors.

Tentative experiments have been carried out in connection with the rôle of the fungus *Cylindrocarpon radicicola* as a possible root parasite of narcissi, *Lilium regale* and strawberries, while others have been concerned with true crown gall and leafy gall in chrysanthemums, and with " cauliflower " disease of strawberries.

Title of paper issued during the year.

1. Buddin, W.: Canker and dry rot of swedes. *Bull. Min. Agric.*, 74, 47, 1934.

85. SEALE-HAYNE AGRICULTURAL COLLEGE

Potato blight.—Detailed observations in relation to the weather were carried out as in previous years. A correlation with the weather map has also been attempted.

Finger and toe.—Soil treatment with proprietary powders has been tried on swede plots on two farms in South Devon, with negative results.

Hot water treatment of narcissus bulbs.—Observations have been continued of growth, flowering and disease incidence in relation to the date of treatment. In addition formalin has been used in the bath and its effect on rootplate rot, etc. will be observed.

Narcissus rootplate rot.—The results of the co-operative trial have been collected and a report issued to those interested. It has been shown the disease can be satisfactorily controlled (but not entirely eliminated) by transplanting to well drained ground, but that there is no improvement on heavy soils.

Violet leaf spots.—A memorandum summarising present knowledge and field observations has been prepared. The fungus is provisionally called *Phyllosticta Violae.*

Anemone Failures.—Last year's observations have been continued and a more extensive plot laid down comprising several varieties, each with two corm sizes.

Minor investigations.—Leaf diseases of narcissi, tulip and iris, snapdragon rust and apple scab have also received attention.

Titles of papers issued during the year.

1. Beaumont, A., and Staniland, L. N.: Tenth Annual Report, Department of Plant Pathology. *Seale-Hayne Coll. Pamph.*, 42, 1934.
2. Beaumont, A.: The control of tulip fire. *Seale-Hayne Coll. Mthly. Bull.*, March, 1934.
3. ———: On the relation between the stage of development of the potato crop and the incidence of blight (*Phytophthora infestans*). *Ann. Appl. Biol.*, **21**, 23-47, 1934.

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86. WYE: SOUTH-EASTERN AGRICULTURAL COLLEGE, LONDON UNIVERSITY

Downy mildew of the hop (Pseudoperonospora humuli).—Investigations into the occurrence of this disease have been made, and the results of those during 1933 have been published (6).

Virus diseases of the hop.

(i) *Chlorotic disease.*—Further evidence was obtained that this disease can be transmitted through the seed. A paper is being prepared for the press.

(ii) *Split-leaf blotch.*—With the co-operation of the grower, investigations were carried out in a garden of Fuggles, near Faversham, Kent, where several hundred hills are severely affected.

(iii) *New virus disease of the Fuggle.*—A disease, in which many of the symptoms closely resemble those of mosaic disease, was investigated in a garden of Fuggles, near Sittingbourne, Kent.

Apple scab.—Spraying experiments have been continued for the eighth year in the College plantation at Wye. Plots of Allington Pippin and Newton Wonder were sprayed respectively with home-made Bordeaux mixture and a vegetable (cotton-seed) oil Bordeaux mixture. The crop was graded by hand for the amount of scab present. The results of the spraying experiments at Wye in 1933 have been published (7).

Pear scab.—The results of the spraying experiments carried out at Sandbanks Farm, Graveney, Kent, in 1933 have been published (8).

Experiments with fungicides.—Biologically-controlled experiments with the hop powdery mildew (*Sphaerotheca Humuli*) were carried out with sulphur-containing preparations, dyestuffs, and modifications of a proprietary mixture. A further contribution, dealing with synthetic solvents has been published (10).

Mushroom diseases.—A paper on the disease caused by *Verticillium malthousei*, and describing the fungus as a new species, has been published (1). Further occurrences of the fungus *Dactylium dendroides* were investigated. This has hitherto been regarded as merely saprophytic but inoculation experiments were carried out which show it to be parasitic. The mushroom bed invaders *Oospora fimicola* and *Papulaspora byssina* (= *Myriococcum praecox*) have both been investigated and an account of their occurrence in England is in course of preparation for publication. The perfect stage of the *Xylaria sp.* which invades mushroom beds has again been investigated and for the second year it has been found to differ from *X. vaporaria.*

Titles of papers issued during the year.

1. Ware, W. M.: A disease of cultivated mushrooms caused by *Verticillium malthousei* sp. nov. *Ann. Bot.*, **47**, 188, 763-787, 1933.
2. Salmon, E. S., and Ware, W. M.: The plum rust on apricot and peach. *Gard. Chron.*, **94**, 2453, 490-492, 1933.
3. Ware, W. M.: Money in mushrooms. *Farmer and Stockbreeder*, **48**, 2321, 802, 1934.
4. Salmon, E. S., and Ware, W. M.: Hop downy mildew: a warning. *Kent Farmers' J.*, **35**, 5, 196, 1934.
5. Burgess, A. H., and Salmon, E. S.: Hop downy mildew. *Ibid.*, **35**, 6, 234, 1934.
6. Salmon, E. S., and Ware, W. M.: The downy mildew of the hop in 1933. *J. S.E. Agric. Coll.*, 34, 107-113, 1934.
7. Goodwin, W., Martin, H., Salmon, E. S., and Ware, W. M.: The control of apple scab: Allington Pippin and Newton Wonder, 1933. *Ibid.*, 34, 136-144, 1934.

8. Martin, H., Salmon, E. S., and Ware, W. M.: Spraying experiments against pear scab. *Ibid.*, 34, 145-154, 1934.
9. Ware, W. M.: Mushrooms. *J. Roy. Hort. Soc.*, **59**, Part 2, 230-235, 1934.
10. Martin, H., and Salmon, E. S.: The fungicidal properties of certain spray-fluids, XI. Synthetic solvents. *J. Agric. Sci.*, **24**, 3, 469-490, 1934.

87. ABERDEEN: NORTH OF SCOTLAND COLLEGE OF AGRICULTURE

British grasses.—The ever-increasing attention being paid to grasses and grassland, renders it important to be able to determine the exact constitution of the sward, especially in the case of grasses when flowers are not available. This department has been engaged for several years on the identification of British grasses by means of cross-sections of the leaf. Grasses have been collected from many parts of the British Isles for study. A paper containing the results of this investigation is in course of preparation.

The economic aspect of grasses is also being kept in view, and grasses collected from a wide area are being grown at Craibstone Experimental Farm for observation. Species and varieties of possible value in turf formation are being experimented with, while the most favourable pH. values for lawn forming species are being investigated.

Fungicidal treatment of seeds.—The investigation into the field performance of seeds of known laboratory germination has been carried a stage further. A wide range of seeds has been experimented with, both with and without fungicides. It is intended to publish the results at an early date. The fungicidal value of these substances has been tried against certain specific diseases which are seed-borne.

88. EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE

Hill pasture investigations.—The investigations on hill pastures which have been carried out at the College Farm, Boghall, were continued. Special attention is being devoted to some types of herbage which have not hitherto proved amenable to improvement, more particularly to land dominated by mat grass or white bent (*Nardus stricta*), an inferior grazing species of wide distribution in hill pastures. Last year an area of this herbage was torn up by mechanical means in order to destroy the surface mat, and afterwards manures and seeds were sown on the area. A marked improvement has been secured by this treatment, *Nardus* has been partially suppressed and the sheep have grazed the herbage very much better than previously.

Previous investigations of land dominated by *Nardus* had shown that the soil is characterised by high acidity and extreme poverty in available phosphates. With a view to elucidating further the soil relationships of this poor type of vegetation, and obtaining more information as to the possibility of effecting improvement by manurial treatment, a series of replicated small plots was laid down. These are treated with various combinations of manures and it is proposed to follow the changes in the herbage and in the soil content of available nutrients resulting from the treatments. This investigation is being carried out in co-operation with the Macaulay Institute for Soil Research. Owing to the dry season little response to the manurial treatments has been visible on the plots this year.

Lawn experiments.—A series of plots has been laid out on a lawn at Boghall and various manurial treatments have been given during the season. Striking alterations in the herbage of the plots have been secured and these are being followed up by botanical analysis.

89. GLASGOW: WEST OF SCOTLAND AGRICULTURAL COLLEGE

Leaf stripe disease of oats.

Control (1, 2).—Most of the work on leaf stripe disease of oats during the year 1933-34 was devoted to control measures. A large number of proprietary seed disinfectants are already on the market, and such disinfectants as were available were tested. A large number of preparations tentatively designed to supersede some of those now in use were also tested.

In the past the work along these lines has involved field trials with seed disinfected with each preparation. This method not only makes large demands on time and money but can be practised usefully only in spring and autumn. In summer sowings the sprout from a germinating grain grows too rapidly to be exposed to serious danger from the resting mycelium of *H. avenae* present on the paleae. Consequently the effect of disinfectants is not readily perceived in summer sown trials. A method by which oat seed disinfectants can be tested in seed pans has therefore been worked out. This enables work to be done either outdoors or in the laboratory and further makes possible a more critical examination of the seedlings and also the detection of the less obvious type of coleoptile infection which occurs under summer conditions. Seed disinfectants may therefore be tested at almost any period of the year and reliable results obtained in a much shorter period than formerly. There seems to be a number of disinfectants coming on the market which in a year like 1934 appeared to give as good results as the standard preparations, simply because the favourable climatic conditions greatly reduced the intensity of the disease in the seedling stage.

Perithecia.—In the Spring of 1934 the perithecial stage of *Helminthosporium avenae* on oat stubble was detected. As far as is known this is the first record of the perfect phase in this country. Perithecia associated with *H. avenae* have been recorded by Rathschlag in Germany (1930) and by Ito in Japan (1930), but their descriptions are not in accord on essential characters. The College specimens correspond closely with those described by Ito, and his name *Pyrenophora avenae* is accepted as superseding the old name *Helminthosporium avenae.*

A technical description of the perithecia found on oat straw has been accepted for publication in the Transactions of the British Mycological Society.

Grey leaf spot of oats.—Grey leaf spot is very common on oat crops in the College area and is well known to be due to a deficiency of manganese in the plant. Its incidence can frequently be traced to an overdose of lime to the soil which appears to interfere with the normal absorption of manganese by the roots. A very interesting case of this relationship was brought to the notice of the College by a farmer in the Glasgow district. Two years ago the young oat plants growing in a particular field on his farm showed the characteristic spotting and withering of the lower leaves. Potatoes were taken from the field in 1933 followed by oats in 1934 and prior to sowing the second oat crop he applied three tons of lime per acre. The result was an alarming increase in intensity of the disease in the seedling stage.

Application of manganese to diseased plants after tillering does not result in any marked response.

In a collection of varieties grown under uniform conditions at Auchincruive, marked differences in susceptibility to manganese deficiency were noticeable and especially in the seedling stage. It would appear that this variation may be correlated with differences in root development in the varieties concerned, especially during the seedling phase.

Rusts of cereals and grasses.—Rusts of grasses were unusually prevalent in the West of Scotland during the autumn of 1933. Special attention was paid to crown rust (*Puccinia coronata*) on oats and ryegrass. Tests of uredospores of the oat strain which have overwintered in the open show that they are no longer viable. During the past summer abundant development of aecidia was obtained on naturally infected *Rhamnus* spp. (excluding *R. frangula*), reported to represent exclusively the ryegrass strain of *P. coronata.*

For these reasons it appears probable the rust epidemics on oats in the province originate from windblown uredospores derived from some other area, either one in which uredospores overwinter or where *Rhamnus* spp. are indigenous and are infected with the oat strain of *P. coronata*. No species of *Rhamnus* is native to S.W. Scotland.

Potato eelworm.—A series of surveys have been carried out on infected farms with a view to keeping check of the changes in the eelworm population of soils worked under various rotations.

Witch's broom of potatoes.—In autumn 1933 a disease of potatoes which appears to correspond closely with that described and figured by American workers as witch's broom of potatoes was detected. The affected plants developed a very large number of slender shoots with greatly attenuated fleshy leaves. An entire plant suffering from this disease yielded only 12 tubers, the total weight of the produce being 91 grms. These tubers were planted in the spring of 1934 and reproduced all features of the disease. The tubers produced by such plants are all so small as to be automatically rejected during the grading of a potato crop and there is little danger of such being used as seed.

Raan of swedes.—This internal mottling of Swedish turnips appears to be increasing in prevalence and is attracting attention also in other countries. Chemical analyses of infected and healthy tissues, carried out by the Chemistry Department, have shown that there is a significant loss in feeding value of attacked roots. The loss appears to be mainly that of sugars, while the percentage of fibre shows a slight increase in diseased swedes.

Although a bacterium can constantly be isolated from the diseased swede tissues proof of its pathogenicity has not been obtained. All evidence available points to raan being primarily a " deficiency " disease which seems to be associated with deficient development of fibrous roots in particularly susceptible varieties.

Dry rot of swedes seems to be correlated in its incidence with raan.

Turf diseases.—A number of diseases which attack turf on bowling and golf greens have received attention. One of these, associated with *Isaria Fuciformis*, is very widespread and causes browning of grass over large areas. Another, which may be caused either by *Fusarium nivale* or by *Rhizoctonia solani*, is commonly known as " brown patch." This causes the grass leaves to die in patches and frequently results in the development of large bare areas in which the grasses have been completely killed out. Experiments are being made with a series of fungicides designed to control these troubles and considerable success has been achieved.

Titles of papers issued during the year.

1. O'Brien, D. G., and Dennis, R. W. G.: The dry disinfection of oat seed. *Trans. Highland and Agric. Soc. of Scotland*, 22, 1934.
2. Dennis, R. W. G.: Studies in the morphology and biology of *Helminthosporium avenae*. *Trans. Brit. Mycol. Soc.*, **18**, 223-238, 1933.
3. ———: A new species of *Pestalotia* on Podocarpus. *Phytopath.*, **24**, 1026-1028, 1934.

VETERINARY SCIENCE

90. BANGOR: UNIVERSITY COLLEGE OF NORTH WALES

Lamb dysentery.—During recent years the spread of lamb dysentery in this Province has been a matter requiring much attention and, latterly, the failure of serum to effect a satisfactory degree of control has caused the problem to assume an even more serious aspect. Further investigation has shown that the intestinal contents of lambs dead of this disease regularly contain one or more of the toxins of the Welch group of bacteria. A study of the types of *B. Welchii* isolated from the intestinal contents of lambs dead of dysentery has shown that only the lamb dysentery bacillus (*B. Welchii* Wilsdon Type B) is present. No satisfactory explanation of the occasional failure of lamb dysentery serum has been forthcoming.

Pulpy kidney disease.—Further work on this disease of young lambs has shown that *B. ovitoxicus* is present in the intestinal contents in all these cases; in some apparently in a pure state, in others mixed with *B. Welchii* of the classical type.

" *Strike* ".—*B. ovitoxicus* has been regularly demonstrated in the intestinal contents of ewes dead of " strike " and in the one case extensively investigated it was apparently the only organism of the Welch group contained therein.

Parasitic gastritis.—This complaint, due to species of the " lesser stomach worm ", caused severe losses among young sheep and young cattle in the southern part of the Province.

Fowl cholera.—Four separate outbreaks of the disease were detected in the Province. In no case could the origin of the infection be traced. The infection did not appear to be so contagious as is usually the case.

Titles of papers issued during the year.

1. Montgomerie, R. F.: Diseases of sheep. *Agric. Prog.*, **11**, 11-15, 1934.
2. Montgomerie, R. F. and Rowlands, W. T.: Lamb dysentery in North Wales. *Vet. J.*, **90**, 323-337, 1934.

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91. BRISTOL UNIVERSITY

Sheep diseases.—Losses among sheep due to parasitic gastritis and enteritis have been extremely heavy, particularly in Somerset, during the winter and spring. The parasites responsible were found to be mainly *Trichostrongylus spp.*; the most effective treatment found consisted of a mixture of nicotine sulphate and copper sulphate. Lamb dysentery and navel ill have caused losses in many flocks; the serum treatment for the former disease is being widely adopted.

Cattle diseases.—All the common diseases of cattle were encountered; parasitic gastritis inflicted heavy losses among young cattle on several farms during the spring.

Pig diseases.—*B. Suipestifer* was found to be the cause of several severe outbreaks among pigs soon after weaning. Careful disinfection of the premises was successful in the prevention of this disease. Anaemia and round worm infestations were occasionally encountered.

"*Teart*" *land.*—Continuing the investigations into "teart" land four animals were grazed in a seven acre field which was reputed to be "teart". None of the animals showed any symptoms suggestive of "teartness" and previous records suggest that no cases occur in times of drought, which climatic condition prevailed during the time the experiment was in progress.

Titles of papers issued during the year.

1. Menzies, D. W.: Johne's disease. *Worcs. Chron.*, **2**, 2, 153-157, 1934.
2. ————: Recent sheep losses. *Farmer and Stockbreeder*, **48**, March 26th, 746, 1934.
3. ————: Poultry disease problems. *Worcs. Chron.*, **2**, 3, 225-227, 1934.
4. ————: The danger of drought to livestock. *Ibid.*, **2**, 4, 303-307, 1934.
5. ————: Some observations on worm infestations of sheep in Somerset. *Bristol U. Bull.*, 10, May, 1934.

92. CAMBRIDGE UNIVERSITY

Lactation tetany in cattle.—The results of an investigation into the causation of this disease have been published (1). A lowered blood magnesium content has been detected on all affected farms where cases of the disease occur, whereas this reduction has not been found on farms free from the disease. Work will be continued to determine the factors causing this mineral upset of the blood.

Fowl cholera.—Five outbreaks occurred during the year and they have been investigated and the farmers advised as to the nature and control of the disease.

Fowl paralysis.—A survey of the incidence of this disease is being undertaken in collaboration with County Poultry Instructors. The variation in leucocyte counts in infected birds has been examined in an attempt to find a satisfactory basis of diagnosis, but it is not considered possible to diagnose fowl paralysis by haematological examination (2).

Bovine contagious abortion.—The eradication of this disease by means of the agglutination test and the segregation of affected cattle is being attempted on a number of farms, and it is hoped by careful observation to determine its effectiveness and the possibility of its more general employment on East Anglian farms. The scheme is being carried out in collaboration with local practitioners.

Bacillus aertrycke infection.—During the past two years, several outbreaks of disease amongst poultry have resulted from infection with *B. aertrycke* and in one instance the organism caused the death of a large number of small pheasants. In this case the distribution of the disease indicated that infected eggs had been responsible.

Titles of papers issued during the year.

1. Blakemore, F., and Stewart, J.: Some observations on several outbreaks of so-called lactation tetany in cattle. Univ. of Cambridge. Inst. of Animal Path. Rept. of the Director. 3rd Rept., 159-168, 1932-33.
2. Blakemore F.: The leucocytes of fowl blood, with special reference to fowl paralysis. *Vet. Rec.*, **46**, 417-422, 1934.

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93. CARDIFF: UNIVERSITY COLLEGE OF SOUTH WALES

Sheep diseases.

Parasitic gastro-enteritis.—This condition was exceptionally prevalent, and was referred to in the Press as " the Mystery Disease ". The Department proved the trouble to be parasitic gastro-enteritis, and showed that its " mysterious " nature was due to the fact that the worms involved were not of the type usually associated with the condition, but belonged to a genus (*Trichostrongylus*) not usually considered particularly harmful. The parasites are much more difficult to find, on post-mortem examination, than are the generally accepted causes of parasitic gastritis, viz. *Haemonchus* and *Ostertagia*, which they greatly outnumbered this season. The worm chiefly involved was *T. vitrinus*.

Lamb dysentery.—The attention of the Department was called to losses among young lambs in Radnorshire and the borders of Breconshire. On investigation the trouble was found to be lamb dysentery. It appears that the disease has been present (although unrecognised) for some years in Radnorshire but that it was more severe this season and seemed to be spreading. At the request of a practitioner the Department also investigated a single outbreak in Monmouthshire. Arrangements have been made for experimental preventive treatment during the ensuing season.

"*Pulpy kidney*" *disease.*—Suspected "pulpy kidney" disease of lambs between the ages of three and six weeks was reported by a practitioner from Carmarthenshire, and was also encountered in Monmouthshire. Unfortunately, the season was too far advanced for definite results to be obtained, both inoculated and uninoculated animals surviving. The information obtained from both localities would seem to suggest that the percentage of losses from "pulpy kidney" is too small to warrant expensive serum treatment.

Suspected louping ill.—This condition was reported by a practitioner from Cardiganshire. The Department is collaborating on the subject with the Moredun Research Institute, Edinburgh, to which samples have been sent.

Suspected chronic copper poisoning.—On a farm in the vicinity of smelting works a large number of adult sheep had died at intervals during the past two years. The symptoms were depression, progressive dullness and emaciation, and death was preceded by haematuria.

On investigation some form of chronic poisoning, probably metallic, was suspected, and analyses of the organs of a three year old and a yearling victim were carried out in the College Chemistry Laboratory, while samples of herbage were sent to the Aberystwyth Advisory Chemist. A large quantity of copper was found in the liver of both animals, and copper was also found in the grass. Experiments are in progress, with the collaboration of the Advisory Chemist, with a view to tracing definitely the source of the copper.

It may be mentioned that the sheep had never received anything containing copper in the way of medicine, but had been drenched with some preparation of iron.

Poultry diseases.

Fowl paralysis.—This condition appears to be spreading. Last season the majority of cases were associated with coccidia; but this year more cases have been encountered where the parasites could not be demonstrated. In a number of cases where the characteristic enlargement of the sciatic nerve was not obvious in the region of the thigh it was found to be very marked in the nerve where it passes behind the kidney. It is possible that this fact may account for occasional mis-diagnosis.

Fowl typhoid.—The vaccine supplied by the Ministry continues to give good results in preventing this disease. A charge of 1d. per dose is now made. The success of its use is evidenced by the fact that the great majority of deaths from fowl typhoid occurred on premises on which the vaccine had not been used.

Tuberculosis.—This disease continues to maintain its unenviable position as one of the chief causes of mortality in adult stock. The Department has tested a number flocks using Pasteur Avian Tuberculin, which has been found most reliable. It is difficult, however, to induce the owners to pay sufficient attention to proper disinfection and hygienic measures, and it is also a problem in some cases to allow infected premises the requisite "fallow" period before introducing fresh stock.

Bacillary white diarrhoea.—This disease has shown an increase in the number of outbreaks as compared with last year. In view of the statement frequently made that markets are one of the chief sources of the disease, the experiment was tried of making bacteriological examinations of batches of chicks purchased in the local market. In no instance were the organisms of B.W.D. demonstrable.

Coccidiosis.—This year the condition was more prevalent in young chicks than it was last year. There was a considerable decrease in the number of cases of infected adult stock.

Infectious entero-hepatitis ("*Blackhead*").—Numerous experiments have been carried out, chiefly in Brecon and Radnor, on the prevention of this disease by the inoculation of various arsenical preparations. The best results were given by a preparation known as "Stabilarsan", but it is the experience of the Department that the most successful method of inoculation is intra-venous, the intra-muscular (the easier) method having proved of little value. The inoculations appear to have no adverse effect on the health of the birds, or on their value for food purposes.

Leukaemia.—There has been a marked decrease in the number of cases of this condition as compared with last year.

Worm infestations.—Cases of worm infestation were more numerous than last season, the chief worms involved being *Heterakis perspicillum*, *H. vesicularis*, and *Davainea proglottina.*

Pig diseases.

Mineral deficiency.—In several instances where freak litters of pigs had repeatedly occurred on certain premises, the Department suspected mineral deficiency, and carried out experiments on those lines. It was finally found that the food of the sows was deficient in iodine, no more freak litters occurring after its administration. In one case the pigs were farrowed, some with no eyes, others with one abnormally large eye, and others with one normal eye and the other three times the usual size. Several similar litters occurred previous to the administration of iodine. In another case the young pigs had malformed heads.

Heat stroke.—In several instances of sudden death among the pigs the cause was found to be heat stroke.

Suspected soya bean meal poisoning.—In the case of several young pigs dying with post-mortem appearances of internal irritation, it was found that the sows were receiving an unduly large ration of soya meal. This would appear to be the cause of the deaths of the young pigs, as bacteriological examinations were entirely negative.

Cattle diseases.

Suspected strychnine poisoning.—Several calves on a farm had died " in fits ", which strongly resembled those seen in cases of poisoning by strychnine. It was found that the stomachs contained large masses of curdled milk, due to hyperacidity. Treatment was recommended after which no more cases occurred.

" *Delirium* " *in newly born calves.*—At the request of a practitioner the Department is investigating cases of newly born calves showing pronounced nervous symptoms. From the time of birth they dash themselves about to such an extent that they have to be specially protected against injury. Several similar calves had been born on the same premises and all had to be destroyed. The investigation suggests that the condition is probably due to some mineral deficiency (possibly magnesium), and experiments are being conducted accordingly. The condition has been encountered on two farms, one in Carmarthenshire and the other in Breconshire.

Tuberculin testing.—The Department is continuing the investigation of the various methods of testing cattle for tuberculosis, and succeeded in arranging a demonstration of the intradermal test at Aberystwyth College Farm. This particular method appears to leave much to be desired, both from the practitioner's and the farmer's point of view. In the case of the demonstration mentioned above, there was by no means general agreement as to the interpretation of the reactions.

Horse diseases.

Grass sickness.—Investigations are still proceeding on the subject of this disease. A number of farms in Carmarthenshire, Cardigan and Pembroke were visited, on each of which an affected animal was examined. The affected animals were typical of one or other stages of the disease as it occurs in Scotland, where the Adviser has again been able to consult various authorities on the subject. A short report is in the course of preparation.

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94. HARPER ADAMS AGRICULTURAL COLLEGE

Lactation tetany.—Among the investigations which have been conducted upon diseases of cattle lactation tetany (so-called Hereford Cattle disease) is of particular interest. A number of cases have arisen in the area and have been located in Warwickshire (near Coleshill), in South Shropshire, in the hilly districts around Craven Arms, Bishops Castle, and Cleobury Mortimer; and in Staffordshire near Market Drayton. The animals attacked are cows in milk from two weeks to two or three months after calving.

The condition manifests itself by nervous symptoms such as twitching of the muscles of the flank, inco-ordination of movement, rolling of the eyes, convulsions and unconciousness. When the disease ends fatally death occurs from two hours to three or four days after the onset of symptoms. Animals sometimes recover, but frequently have a relapse and death follows the second attack. Whilst post-mortem lesions are not consistent they are chiefly confined to the vascular system. Haemorrhagic pericarditis, blood splashing, and a hydraemic condition of the true stomach and intestines are frequently present. Biochemical examination of the blood of animals showing signs of the disease has in all cases revealed a deficiency in magnesium, the magnesium content of the blood sometimes being one-quarter of the normal figure and frequently less than half. The calcium content is also lowered in all cases.

The disease appears to be due to a deficiency of essential substances in the diet. The supply of green food such as cabbages, kale, and clover (which are rich in mineral salts) is of value, particularly when animals are mainly dependent upon poor hay or pasture. The examination of blood samples and of the soils and herbage has been carried out with the co-operation of the Animal Diseases Research Association of Scotland, and Harper Adams Agricultural College.

Parasitic gastritis in sheep and cattle.—Owing to the dry season with the consequent shortage of grass serious outbreaks of this disease have occurred. The animals have been obliged to graze closer to the ground and large numbers of infective larvae have been picked up, with the result that severe parasitism has occurred. Where large sheep stocks are kept the losses have been the heaviest. Ewes have been attacked, soon after lambing, in large numbers. There has been a high mortality and several owners have lost 25 per cent. of their sheep. The consequent loss of milk has resulted in poor condition of their lambs. One post-mortem examination upon a three-year-old bullock revealed no less than 140,000 worms in the fourth stomach.

Many farmers are finding that it pays them to keep half the stock their land is capable of carrying on account of these parasitic conditions.

The disease has been found to be caused by the following :—*Trichostrongylus extenuatus*, *T. vitrinus*, *T. Colubriformis*, *Ostertagia circumcincta*, and *Cooperia oncophora*.

The total number of parasites found varied up to 58,000 worms in the stomach and to 45,000 in the intestines. Further work upon the control of parasitic conditions of stock in the province is urgently needed.

Contagious abortion of cattle.—Control of this disease by means of segregation of reactors from non-reactors and frequent agglutination tests is being attempted.

A large number of veterinary practitioners are co-operating in this work. The agglutination tests are conducted at regular intervals of from four to six weeks. The farms are selected and are self contained with suitable buildings and pastures for this purpose.

The value of various dead vaccines produced by different methods is under investigation. This work has been carried out with the co-operation of the Veterinary Laboratory of the Ministry of Agriculture and Fisheries.

Infectious conjunctivitis of sheep.—Two outbreaks of this disease have occurred in Shropshire and Warwickshire. These were satisfactorily controlled following the use of Silver Iodide solutions.

Poultry diseases.—Coccidiosis appears to be the most serious disease amongst poultry. The duodenal type has been more prevalent than usual.

The following diseased conditions have shown an increased incidence: parasitic infestations, tumours, fowl pox, avian tuberculosis, nero-lymphomatosis.

Blackhead (entero-hepatitis) of turkeys.—Investigations with various arsenical preparations have shown that these substances are of value in the control of this condition.

Title of paper issued during the year.

1. Wright, T. S.: Some preventable diseases of pigs. *Vet. J.* **90,** 3, 127-130, 1934.

95. LEEDS UNIVERSITY

Parasitic diseases.—Several outbreaks of parasitic gastritis in young cattle were investigated. One of these was of a serious nature and resulted in the death of several stirks. The infection was a mixed one, the predominant worm being *Str. Ostertagia.*

Haemorrhagic Septicaemia.—Several serious outbreaks of this disease in cattle were investigated. In one outbreak a number of feeding bullocks were affected, and six of them died. Vaccination with haemorrhagic septicaemia Aggressin was tried on the remainder with very satisfactory results.

Poisoning.—Several cases of linseed poisoning in young calves were investigated. In all cases the linseed was prepared by steeping in hot water but was not boiled. Boiling the linseed appears to be the best method of preventing this form of poisoning.

A suspected case of yew poisoning in ewes was also investigated in which the yew twigs were believed to have been blown into the pasture from adjoining gardens during a heavy gale of wind.

Deficiency diseases.—Several outbreaks of disease believed to be due to some deficiency condition were investigated and in one case, involving the loss of a number of cattle, there was some evidence that it might possibly be due to an iron deficiency.

96. LIVERPOOL UNIVERSITY

Contagious abortion.—Nine herds have been brought into the Agricultural Research Council's abortion control scheme, involving some 575 animals at the initial test, with 41 per cent. reactors. Approximately four main herd tests have been carried out at three month intervals. Results to date have been distinctly encouraging.

Wastage in dairy herds.—In the autumn of 1933 the survey of the disease in Lancashire was extended and now embraces approximately 40 milk recorded herds, containing 1,700 head of stock, in the county. Records are available giving full information concerning the method and cause of disposal of approximately 200 cows from 23 herds, with the history of each animal and farm.

Mastitis has been responsible for the greatest proportion of disposals. Next in order come sterility and low milk yields. Actual trade disposals are low. Johne's disease, contrary to expectation, does not figure prominently in the wastage figures.

Streptococcic mastitis.—The method of control outlined in the last annual report has been continued and extended to two other farms. The results are very encouraging and the system is now being adopted by veterinary practitioners with satisfactory results.

Poultry diseases.—A survey into the incidence of fowl cholera in Lancashire was instituted following reports of the disease in material from Lancashire examined at the Weybridge laboratory. Preliminary enquiry revealed conflicting opinion as to the occurrence of the disease in the area. It appears that losses from a disease resembling fowl cholera have been occurring for a considerable time.

Two outbreaks in Lancashire and one in Liverpool were confirmed during 1934. The last outbreak was conspicuous for its heavy mortality, which has continued over a number of years. Wattle cases were frequent, and cultures from the oedematous wattles showed the presence of a low-virulence strain of *Pasteurella* sp.

Parasitic gastritis in sheep and yearling cattle.—Practitioners in the Lancaster district are concerned about the evidence of parasitic gastritis in young cattle and sheep in this area. Of all parts of the advisory area the Lancaster district appears to suffer most from losses due to Johne's disease and parasitic gastritis. *Ostertagia ostertagi, Haemonchus contortus* and *Trichostrongylus extenuatus* have been incriminated in several outbreaks, the latter occurring in yearling cattle. In response to an invitation received from the Director of the Veterinary Laboratory, Weybridge, a survey of losses due to parasitic gastritis in sheep has been instituted. No unusual losses have been reported in sheep from this condition, the majority of enquiries relating to cattle. Lancashire to a certain extent escaped the hard grazing condition so prevalent throughout the country during the autumn of 1933.

Ascariasis in pigs.—The eradication of *Ascaris* from a herd of pedigree Middle Whites has been the subject of investigation for some considerable time. A modified McLean County System combined with oil of chenopodium treatment controlled by microscopical examination of faeces for worm eggs has been in progress. Under ordinary conditions breeders are advised to wash sows before farrowing and to farrow in clean buildings. Small pigs in the litter are then dosed with oil of chenopodium (1 c.c. per 25 lb. body weight) shortly after recovering from the check of weaning and again at 90-100 lb. body weight, that is when they are becoming too big to handle. This method has proved itself to be of inestimable benefit in badly infected herds, but is not readily applicable to ordinary commercial herds.

Contagious pneumonia in pigs.—An outbreak of contagious pneumonia with nasal discharge in a group of fat bacon pigs was investigated. *Ascaris* infection, as suspected by the owner, was ruled out on post-mortem examination, which revealed extensive pneumonic lesions of a lobular broncho-pneumonia in each case. The condition bore every indication of a pasteurella pneumonia. Losses commenced shortly after the hot spell in June; there was a history of constant exposure to the sun with consequent heat exhaustion through lack of shade.

97. MIDLAND AGRICULTURAL COLLEGE

B.C.G. vaccination.—In the two herds in which this process has been carried out since 1928, vaccination has this year been discontinued. In the case of one herd the main reason was want of understanding co-operation in the owner together with the fact that the herd was no longer being run as a self-contained one. In the other case the herd now practically consists of vaccinated animals and an attempt is now to be made to raise a tubercle free herd.

Vaccination has, however, been undertaken in another herd where the technique recommended by Professor Buxton is being used.

Contagious bovine abortion.—A trial of vaccination by devitalised vaccine, as supplied by Dr. Andrews, is being made in an infected herd. Up to the present 17 animals have been treated and out of these one has aborted, two have calved dead calves and two have calved normally. The remainder are still to calve.

Avian tuberculosis.—Investigation of the efficiency of the tuberculin test has been continued and comparison has also been made of the relative efficiency of the wattle test as compared with that in which tuberculin is injected in the infraorbital position. Over 1,000 birds have been tested and 79 have given positive reactions.

Although some number give a reaction to the "eye" test only, a greater number give a reaction to the wattle test only. From this it would appear that the "eye" test is of value only when used as supplementing the wattle test.

"*Blackhead*" *in turkeys.*—The experiment was made in one lot of about 60 birds. These were divided into three equal and even lots. One lot received treatment with an organic preparation of arsenic. Another were given half a c.c. of carbon tetrachloride in capsule. The third lot received no treatment. The birds were treated twice, once on the 7th July and again on the 31st. Fifteen birds have died and of these ten have shown the characteristic post-mortem lesions of "Blackhead." Of these ten four had received arsenical treatment, two had been treated with carbon tetrachloride, and four had received no treatment.

98. NEWCASTLE: ARMSTRONG COLLEGE, DURHAM UNIVERSITY

Lamb dysentery.—A year ago the Adviser recorded outbreaks of dysentery in lambs which failed to respond to serum treatment. Similar complaints were made by farmers during the 1934 lambing season; therefore it is a matter for reasonable doubt whether or not lamb dysentery serum and vaccine possess any prophylactic properties for the type of dysentery now common. Dalling and Montgomerie and Rowlands have already referred to loss of power of *Cl. Welchii* strains to produce certain types of toxin, but it is to be noted that vaccine and serum breakdown were observed in cases where these products were reinforced with the missing toxins and antitoxin. The whole question of prophylactic treatment against dysentery is now under review and new experiments are being laid down.

Braxy or sickness in hoggs.—Generally speaking biological control of this disease has been placed on a satisfactory basis, but one or two instances were reported where losses persisted in spite of single-dose vaccination. One farmer lost 43 hoggs from braxy out of 200 vaccinated. This farm is notorious for the disease, and it would appear that here there is a strain variation at work or the immunity induced was insufficient to induce protection. This matter is being investigated.

Louping ill.—Using vaccine supplied by the Moredun Institute, the Adviser carried out an experiment to test the value of this vaccine in preventing the disease among susceptible hoggs. On twelve farms 756 hoggs were vaccinated in March and on these farms 764 were left as controls. Of the principals three were reported as having died from louping ill, while 47 controls or over 6 per cent. died from this disease. The use of the vaccine in young lambs was not so successful. This is the third year in succession that a favourable result has been obtained in hoggs.

Parasites in sheep and cattle.—Many outbreaks of parasitic disease were encountered in sheep and cattle during the autumn and winter months. Observations were made on the pathology of the disease and on the type of parasite present. The anaemia produced in sheep is of the low colour index variety, and a noticeable feature is seen in the lymphocytes, which are generally increased in proportion and numbers. A controlled experiment was run to test the value of certain drugs in curing the disease, and the results of this work have already been published.

Pining in sheep.—Work on this disease has been continued throughout the year, and it is hoped to publish a full account of the investigation.

Cripples in lambs.—Further observations were made on this disease, and experiments were conducted with the idea of showing whether the land or the breed of sheep were factors in its causation. The value of a vitamin C supplement to the food of certain ewes was also noted. On the whole the results of these experiments were negative, and in the future it is intended to test the breeding or hereditary aspect more closely.

Bovine contagious abortion.—A limited amount of work has been done on this disease, and certain evidence has been obtained which indicates that there is a material difference between a natural and an artificial infection, such as produced by the inoculation of live cultures of *Br. abortus.* This work also suggests that the inoculation of live culture is not an active agent in spreading the disease. It is hoped to be able to continue this work.

Titles of papers issued during the year.

1. Stewart, W. Lyle, and Westwater, C. H.: The eradication of contagious abortion. *Vet. J.*, **89**, No. 12, 536, 1933.
2. Stewart, W. Lyle: "Cripples" in lambs—I. *Ibid.*, **90**, No. 2, 53, 1934.
3. ———: "Cripples" in lambs—II. *Ibid.*, **90**, No. 6, 223, 1934.
4. ———: Parasitic gastro-enteritis in sheep. *Vet. Rec.*, **14**, No. 39, 1165, 1934.

99. READING UNIVERSITY

Fowl paralysis.—This disease is of primary importance to the poultry industry at the present moment and in view of the obscurity of its etiology and the conflicting evidence concerning its epidemiology, it is likely to remain so for some years. It is a problem which must be attacked on a very large scale and with the facilities available it is only possible to attack certain aspects of it. The changes which occur in the blood stream of affected birds provide insufficient evidence to warrant a diagnosis of the presence of the disease. When these are sufficiently obvious then there are usually more reliable lesions to be observed in the nerves themselves.

Mastitis.—Work on this disease is being continued with the object in view of ascertaining the relationship of low solids-not-fat to the presence of mastitis.

Paratyphoid infection of swine.—A severe outbreak of a disease occurring in store pigs between the ages of three to five months during the summer months was shown by investigation to be due to infection by an organism of the Salmonella group, *B. suipestifer.* This organism was isolated in pure culture from the organs of affected pigs.

It was thought there might perhaps be a number of carriers amongst the sows and that these might be responsible for the outbreak. In order to ascertain this point and also to be in a position to make suitable recommendations, 100 of the 150 breeding sows were blood tested. Twelve were found to possess abnormally high titres. This investigation has not yet been concluded.

Parasitic infection of sheep.—Following upon the abnormally dry climatic conditions which prevailed during the year under review a number of unusual outbreaks of Trichostrongylosis in sheep occurred. Three cases were investigated in Northamptonshire.

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100. SEALE-HAYNE AGRICULTURAL COLLEGE

Poultry.—An organism responsible for beak lesions among battery brooder chicks has been typed as *Cl. Welchii* of very low capacity in toxin production.

" Blackhead " in turkeys was successfully dealt with by inoculation treatment. The method is now being passed on to the practising veterinary surgeons in all possible cases. Arsenical preparations were used.

Pigs.—Pneumonia, in which the only germ isolated as a septicaemic invader was *Salmonella suipestifer*, has been diagnosed. Generally a tightening up of hygiene stopped losses. In one case *Pasteurella suisepticus* was isolated, and successful results were obtained following treatment with anti-serum of the haemorrhagic septicaemia type.

Silver foxes.—Bacteriological examination of cubs which died on a ranch gave *Salmonella suipestifer* in pure culture, as a septicaemic condition. Careful attention to hygiene was all that was imposed, except for stimulating treatment by the attending veterinary surgeon in a few cases, and this brought the outbreak to an end.

101. WYE: SOUTH-EASTERN AGRICULTURAL COLLEGE

Sheep diseases.

"*Struck*".—On some farms the mortality was low and vaccination had no effect but on others the mortality among the control was relatively high whereas among the vaccinated it was low.

"*Gangrene*".—The inoculation of serum has again been favourably reported on.

Johne's disease.—This disease is still being encountered in the flock first reported on in 1932.

Haematogenous jaundice.—A disease of sheep comparable in many respects to the "toxaemic jaundice" reported from Australia was found on a farm in Kent. The disease was not transmitted by inoculation. The aetiology is quite unknown.

Parasitic gastritis and enteritis.—Losses from parasitic gastritis and enteritis were many. The smaller stomach and intestinal worms appeared to have been responsible on the majority of farms. Large doses of copper sulphate and nicotine sulphate in solution have been used in the treatment of affected sheep.

Contagious abortion in cattle.

Work has been done on the control of this disease.

Title of paper issued during the year.

1. McEwen, A. D., and Roberts, R. S.: The results of the double intradermal test for tuberculosis in a small dairy herd. *J. Comp. Path. and Therap.*, **47**, 32-48, 1934.

AGRICULTURAL AND DAIRY BACTERIOLOGY

102. ABERYSTWYTH: UNIVERSITY COLLEGE OF WALES

Thermoduric and thermophilic flora of raw milk.—A series of fresh milk samples from a farm known to contain large numbers of heat resistant bacteria were examined by laboratory pasteurisation for 30 minutes at 145° F. Seventy-five per cent. of the samples gave results showing a pasteurisation efficiency under 99 per cent. Half the number of samples gave a pasteurisation efficiency of under 50 per cent.

Only 30 per cent. of the samples, however, produced definite fermentation of milk when incubated for 48 hours at 145° F., whereas organisms were detected in 50 per cent. on microscopical examination. An attempt is being made to correlate the presence of heat resistant organisms with the presence of thermophiles. Bacterial growth on milk agar plates incubated at 145° F. for three days was only obtained in two samples, and then only a total of three colonies of *Actinomyces*. This may well be due to air contamination at the laboratory.

A comparison is now being made of incubation in milk agar and yeast dextrose agar plates at 55° C. and at 62·8° C.

A comparison of the keeping quality of fresh milk.—A series of 585 samples of raw milk have been examined for keeping quality at 60° F. by the methylene blue reduction test, and by taste, aroma and clot on boiling. Comparative readings were taken twice daily at 9 a.m. and 5 p.m. The results obtained indicate fairly close agreement between the two methods when samples having keeping qualities of three to four days are compared. Samples with low keeping qualities under three days show a wide variation.

A further series of samples is being examined by the two methods; the number of observations during the critical period being increased.

Title of paper issued during the year.

1. Thomas, S. B.: The bacteriological examination of raw milk by means of the milk agar plate count method. *Welsh J. Agric.*, **10**, 295-301, 1934.

103. BANGOR: UNIVERSITY COLLEGE OF NORTH WALES

Numerous investigations have been made into problems concerning high bacterial counts, high coliform contents and abnormal taints in milk supplies. Such investigations have generally revealed inefficient methods at some stage of production.

Investigation was made into a persistent case of high coliform content, which was suspected by the owner of the herd to be due to the presence of *B. Coli* in the udder of one or more cows. Bacteriological examination of the milk of individual cows gave negative results, and further investigation revealed inefficiently sterilised churns as the cause. A second case of high coliform content in certified milk was traced to the inefficient cleaning and sterilising of the milking machine.

An outbreak of " ropy " milk was traced to a contaminated water supply, to which the cows had access, the outbreak being aided by the generally poor conditions of production. After the elimination of the source of contamination and with improved conditions of production, no further trouble was experienced.

The Dislac test for mastitis and other udder troubles has been carried out with several herds, and revealed in many cases a high percentage of cows giving abnormal milk from one or more quarters.

104. BRISTOL UNIVERSITY

" *Carrot* " *taint in milk.*—The development of a flavour highly reminiscent of carrots has been noticed in milk samples from one farm. The farmer in question is a county accredited producer submitting monthly samples, and the peculiar taint developed in five consecutive samples, commencing in October, 1933. In three instances the taint was noticeable when the milk reached the laboratory at approximately 26 hours old, and in the other cases it developed within the next 24-30 hours at 60°F. Conditions on the farm appeared to be normal, the only feature of note being the feeding of somewhat inferior silage to the cows. The bacterial counts never exceeded 5,000 per cc. and *B. coli aerogenes* contamination was never present in higher dilutions than one-tenth cc. as measured by the presumptive test at 37°C. Moreover, the milk did not coagulate on boiling for 2-3 days after being condemned on taste. Early attempts to isolate an organism failed, but later, by incubating the milk agar plates for 4-5 days at 37°C. very minute colonies developed and the organism isolated therefrom was found to produce the " carrot " flavour.

The opportunity to trace the source of the contamination on the farm did not arise but it is interesting to note that the time when the taint was present in the milk coincided exactly with the period during which the silage, referred to above, was fed. Further work on the biological characters of the organism is being conducted as time permits.

Torula yeast in cheese milk.—A complaint, from two farms, of severe gassiness in cheese-curd was brought to the notice of the Dairy Bacteriologist in June last. While Coliform contamination was not entirely absent from the bulk milk samples, the nature of the gassiness in the curd strongly suggested that yeasts were the major cause of the trouble. The conditions on both farms were reasonably good, and efforts to control the fault by scrupulous care in the production and handling of the milk and by thorough sterilisation of utensils were futile. Samples from some cows in the herds contained abundant yeasts which produced alcoholic fermentation with a torn curd very rapidly when held at 80°F. Simultaneously, curd tests of individual cows' milk were conducted on the farm, when it was seen that the gassiness only developed in the milk from some cows, and when the milk from those cows was withheld from the vat, good cheese resulted. Further samples from the suspected cows, carefully drawn direct into sterile bottles from the last portion of the milk produced, after the udders had been thoroughly cleansed, again showed an abundance of yeasts. The yeast is oval in shape and is probably *Torula cremoris.* The findings of this investigation would lead one to suggest that the yeasts originated from the interior of the udder, but as a teat-syphon has not been available for taking samples, final confirmation is withheld meantime.

Methylene blue reductase test.—Interest in this test has been renewed and the Dairy Bacteriologist is participating in the correlation work on this subject with some other advisory centres and the National Institute for Research in Dairying, Reading.

High acidity in milk.—A case has occurred where a low grade sample of crushed oats was considered responsible for very high acidity in newly-drawn milk. On three separate occasions when 5 lb. of the oats per head were fed to the cows, the newly-drawn bulk milk showed abnormally high acidity, so high indeed, that the milk clotted on boiling, and in one instance slight coagulation was noticed when the bulk milk passed over the cooler. Unfortunately, the trouble was not brought to the notice of the Dairy Bacteriologist until the supply of oats was almost exhausted, therefore, controlled feeding trials could not be conducted. A sample of the oats when examined showed evidence that the grains had, at some time, undergone considerable fermentation. Upon digesting the oats in water at 37°C. for 24 hours a strong odour of acetic acid developed, and agar-plate cultures of the supernatant fluid produced an almost pure culture of *Bacterium aceti.* Control samples of sound oats when treated in a like manner produced no acetic acid fermentation, nor could *B. aceti* be isolated from plate cultures.

Title of paper issued during the year.

1. Egdell, J. W.: The care and sterilisation of milking machines. *Worcs. Chron.*, **2**, 4, August, 1934.

105. CAMBRIDGE UNIVERSITY

Work has been started on the variations due to sampling. Several groups of samples resulted in almost complete agreement in respect of butter-fat content and degree of coliform contamination. The variation in the case of bacterial count has been investigated to determine the effect of chance in withdrawing one cubic centimetre, the effect of variations as between pipettes and the effect of position in the incubator. The work has been suspended, partly by reason of lack of incubator space resulting from the large number of routine samples and partly owing to the large amount of time devoted to field-work.

In conjunction with the Plant Bacteriologist to the Botany School, work has been continued on the colour producing strains of *B. prodigiosus.*

As a result of the complaints of " flecking " in milk some preliminary work has been done on the effect of mineral solutions added to milk. A tentative proposal for an experiment to be conducted on the University Farm has been put forward—details of the ration in use at the time of the occurrence having been supplied by the farmer.

106. HARPER ADAMS AGRICULTURAL COLLEGE

Reductase test.—Results from 500 samples were obtained during the year using a modified technique for the reduction of methylene blue at 15°C. as a test of keeping quality. These showed that the test is moderately accurate for milk keeping about 3 days, but that for a keeping period less or more than this it is increasingly unreliable.

Media for plate counts of milk.—The results of a comparison of milk agar with standard agar as a medium for determining the numbers of bacteria in pasteurised milk confirm those previously reported at Reading for raw milk, but the differences obtained are more striking. Results with 0·1 c.c. cultures on the two media agree fairly closely, but with cultures from 0·01 and 0·001 c.c. the results on milk agar may be even 10-15 times as high as on standard agar. Colonies are more easily counted on the milk agar cultures.

Bacterial decomposition of eggs.—A more detailed examination of twelve main types of organism isolated has shown that the taint previously reported in preserved duck eggs is produced by one type of organism but others are often present.

In addition to the normal troubles experienced with milk, cheese and butter, advisory problems entailed work on the growth of *Cladothrix* in sugar beet effluents, taints of milk, including maltiness (due to a variety of *S. lactis*) and a methylated spirit taint and the carbolic taint of sterilised milk. A case of gassiness in cheese was also investigated.

107. LEEDS UNIVERSITY

During the year investigations have been carried out on problems concerned with the cause of poor keeping quality of milk and taints and abnormal flavours in milk and cream. In the majority of cases the cause of the poor keeping quality and the development of abnormal flavour was due to contamination of the milk with coliform organisms of the *B. lactis aerogenes* type. Unsterile milking machines are a fertile source of this organism and once it establishes itself in the rubber piping very thorough sterilization by steam is necessary to remove it.

An investigation was carried out during the summer into the cause of a high bacterial count in samples of "certified" milk. The result of the investigation showed that a number of the cows were infected in the udder with a strain of *Staphylococcus aureus*. In a few cases this organism was the cause of a mild mastitis which later developed into an acute type. It is interesting to note that this observation has been confirmed in other herds and that when the mastitis becomes acute the *Staphylococcus aureus* is replaced by *S. mastitidis*.

A summary of the research work on the causal organism of foul brood of the honey bee has been published (2).

Titles of papers issued during the year.

1. Chalmers, C. H.: The significance of true *B. Coli* (*B. Coli communis*) and *B. lactis aerogenes* in samples of milk. *Centralbl. f. Bakt.*, 11, 89, 1934.
2. ————: Foul brood of the honey bee. *Rep. Rothamsted Conf.*, No. 18, 1934.

108. MIDLAND AGRICULTURAL COLLEGE

"*Ropy*" *milk*.—This work commenced in the previous year was completed. The investigation showed that out of 80 samples of milk from 30 farms during the months of September, October and November, 21 samples contained ropy milk bacteria. Only one farmer who was a producer retailer had had any complaint of ropiness, and this indicates that the presence of a few ropy milk bacteria in milk is of little commercial significance when the milk is pasteurised at an early age. The most common source of the organisms was found to be water, but the possibility of infection being carried by unsterile churns from the dairy is pointed out. An actual case of complaint of ropiness in a farmer's milk was traced to this source during the summer.

Pin point colonies on plates from raw milk.—The work on the presence of pin point colonies on agar plates as an indication of udder infection in a herd is being continued.

Pink discoloration of butter.—During the early part of September a case of persistent pink discoloration of farm butter was brought to the notice of the Adviser, and the cause of the defect is being further investigated.

Titles of papers issued during the year.

1. Rowlands, A.: The essential factors in the production of clean milk. *Derbyshire Farmer,* **13,** 10, 1933.
2. ———: Milk taints and their prevention. *Notts. Milk Rec. Soc. Handbook,* 1934.
3. ———: " Ropy " milk. *Dairy Farmer,* October, 1933.

109. NEWCASTLE: ARMSTRONG COLLEGE, DURHAM UNIVERSITY

Contagious abortion.—A report has been issued of an experiment on the eradication of contagious abortion. Work of a similar nature on other dairy herds is being continued in conjunction with the Adviser in Veterinary Science.

Ropy milk.—With a continuance of dry weather over a considerable period streams were frequently left in a semi-stagnant condition and the access of cattle to such water was usually the starting point of contamination. Numerous requests for assistance were received and in each case it was possible to overcome the difficulty.

Graded milk farms.—The enquiries were for assistance in tracing the cause of high counts or coliform contamination. They came mainly from farms where milking machines were employed, and it was generally found possible to trace the source of contamination.

Title of paper issued during the year.

Stewart, W. Lyle, and Westwater, C. H.: The eradication of contagious abortion: A Northumbrian experiment. *Vet. J.,* **89,** 12, 536-544, 1933.

110. READING UNIVERSITY

The use of vacuum flasks for the transport of samples.—The object of the adoption of vacuum flasks for this purpose would be to lessen, if not to eliminate, the effect of atmospheric temperature on samples submitted for bacteriological count. Cheap vacuum flasks have been obtained which will withstand sterilisation without fracture, a packing has been devised which enables these flasks to travel through the post and under experimental conditions the temperature of milk kept in the flasks is such that extremes of atmospheric temperature may be experienced with little effect on the sample. This work is being continued.

The development of a satisfactory low temperature (60° *F.*) *incubator for the storage of milk samples.*—The usual method of temperature control is by means of a water jacket around the incubator chamber in which there is no air agitation. During routine testing in a milk testing laboratory more or less frequent opening of the incubator is necessary with the result that a constant temperature of 60° F. is very far from being attained.

The design being tried out depends on rapid circulation of the air within the chamber through a conditioning chamber in which the temperature is adjusted by means of the condenser coils of a direct expansion refrigerator and an electrical resistance heater electrically operated through relays by thermostatic control. Results have so far been good but some modification of the heating unit would appear to be necessary.

Correlation Scheme.—The carding of samples is now complete and the cards are filed ready for analysis.

Duplicate testing scheme.—The results obtained have been examined statistically. Based on the experience of this work arrangements are being made for running a new scheme of the same nature incorporating a series of tests carried out using new technique recently adopted.

111. SEALE-HAYNE AGRICULTURAL COLLEGE

The energies of the Adviser have been mainly concentrated on a clean milk competition and the problems arising therefrom.

Contaminated water supplies.—Several cases of high bacterial counts and coliform (*B. coli communior*) contamination were found to be due to the use of contaminated water supplies, which were being used for the washing of utensils and the udders of the cows previous to milking. As a precautionary measure, whenever there was any doubt as to the purity of any competitor's water supply a sample was taken for bacteriological examination.

Milking machines.—It was found that the competitors who used milking machines did not produce the cleanest milk, and it was found in several cases to be very difficult to drive home to them the absolute necessity for thoroughly sterilising all parts of the machine daily.

Mastitis.—Mastitis and udder infections were in some cases found to be the cause of high bacterial counts and in one case (coliform mastitis) of coliform contamination. The use of "milk agar" greatly facilitated the detection of high counts due to this cause.

112. WYE : SOUTH-EASTERN AGRICULTURAL COLLEGE, LONDON UNIVERSITY

Thermal insulation of milk samples.—Experiments have been carried out with balsa wood containers for the transit of milk samples. It was found that balsa wood had considerable value as an insulator for milk samples and effected considerable delay in the rate of rise of temperature of the sample, and further that its insulating effect was greatly increased by pre-cooling the container and sample bottle. The chief difficulty in the use of balsa wood is its comparatively high cost (2s. 6d. per container if 100 were purchased).

Other investigations.—The statistical investigation into the interrelationship of bacterial content, coliform content and keeping quality has been completed and a report has been prepared for publication.

Work has been continued on Van Oijen's test, samples being tested five-fold and at different ages, and comparative plate tests made ten-fold. This work is still in hand.

With the co-operation of the Kent County Staff a series of tests has been made with the object of gauging the effect of varying methods of mixing bulk milk on the bacterial content, fat content and keeping quality of the samples. Analysis of results has yet to be made.

A series of tests has also begun, the samples being tested at four and at twenty-four hours old and held in constant temperature. The aim is to gauge the increase in count.

Titles of papers issued during the year.

1. Ball, W. J., and Barkworth, H.: Laboratory checkings of capillary pipettes. *J. S.E. Agric. Coll.*, **34**, 254-255, July, 1934.
2. ———: Measuring 1/10th c.cm. milk. *Ibid.*, **34**, 256-257, July, 1934.

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113. EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE

The microflora of A.I.V. silage.—The investigation of the microflora of A.I.V. silage was continued. A number of samples of silage prepared from a mixture of beans, peas and tares were examined. The results were in agreement with those previously reported and indicated that some microbiological activity had taken place in the silo. The work is being continued.

The Burri smear-culture method for determining the bacterial content of milk.—A paper describing the results of the investigation of the Burri smear-culture method has been published (1).

Disease of cultivated mushrooms.—A disease of cultivated mushrooms was investigated. In the early stages of this disease brown spots appear on the stems. Later the discoloured areas extend upwards and downwards. The mushroom when cut appears dark brown in colour: it is at first hard but later becomes soft, tough and rubbery. Affected mushrooms remain small and bacteria can be cultivated from them with regularity. Infection experiments with pure cultures obtained from diseased mushrooms are in progress.

The anaerobic bacilli of farmyard manure.—A paper on this subject has been published (2).

Titles of papers issued during the year.

1. Cunningham, A., and Andrews, A.: The Burri smear-culture method for the determination of the bacterial content of milk samples. *J. Dairy Res.*, **5**, 29-41, 1933.
2. Glathe, H., and Cunningham, A.: The obligate anaerobic microflora of farmyard manure. *J. Agric. Sci.*, **23**, 541-554, 1933.
3. Cunningham, A.: Practical bacteriology. Sec. Edition, 203 pp., 1934. Oliver and Boyd, Edinburgh.

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114. GLASGOW: WEST OF SCOTLAND AGRICULTURAL COLLEGE

MILK PRODUCTION.

Protein requirements of cows.—A trial was completed in which decorticated earthnut cake, decorticated cotton cake and palm nut cake were used as protein supplements for cows in milk. It was found that in changing from ration to ration the variations in milk production were never more than 4 per cent. and the changes in fat production always less than 7 per cent. and so can be considered of no importance.

This, with previous trials, aids in the proof that in the past there has at times been a tendency to give too high a protein allowance to cows. The majority of the feeding standards call for too high a protein allowance. Quality is of more importance than quantity.

Dairy ration types.—A ration composed of oat straw, dried beet pulp, bruised oats and bean meal was compared with one containing mangolds, hay and a grain mixture. Each individual cow yielded better on the second ration than on the first, the increase averaging 11·5 per cent. in milk and 6 per cent. in fat.

The difference is probably due in part to the presence of plenty of succulent feed and good hay in the second ration. In addition it must be admitted that though bean meal is a good feed for dairy cows there are mixtures which can excel it both for total milk production and economy of production.

Pasteurised milk for calves.—The work on pasteurised milk for calves was in part finished in the previous year.

From the results of this trial it would appear that where calves are fed milk, hay and grain there is a difference in the way in which bull and heifer calves react in live weight gains to the feeding of pasteurised milk. Bull calves appear to do less satisfactorily on pasteurised than on raw milk, while in the case of heifer calves the difference in less marked.

One aspect of these differences constitutes a problem in nutrition. It is also probable that the length of time during which calves are fed the colostrum from their dams may mean much in the prevention of disease. The minimum length of time during which the colostrum should be fed is not definitely known as yet, but apparently, in the case of bull calves at least, it is more than five days.

All bull calves were subjected to the double intradermal tuberculin test on one occasion during the trial while the heifers were tested twice. The reactors were three heifers in the winter group put on pasteurised milk after five days on colostrum and one heifer in the spring group kept on raw milk throughout.

All the heifers which passed the tuberculin tests were retained in the herd and weighed at 1 year of age. The heifers raised on raw milk throughout made a live weight gain from birth to 1 year of age of 496 lb. or 590 per cent., while those on pasteurised milk after 10 days of age gained only 443 lb. or 554 per cent.

Colostrum for calves.—A few small trials have given corroboration to the previous work in showing the value of colostrum to young calves.

Hoven.—In the work on hoven considerable additional evidence has been found that this condition is probably largely due to the presence of a saponin and a cyanoglucoside in wild white clover. There is a seasonal variation in the occurrence of these compounds which goes with the seasonal variation in the occurrence of bloat.

It would also appear probable that the occurrence of bloat is connected with a lime deficiency in the soil. With a limited lime deficiency wild white clover grows more luxuriantly than the grasses, while at a still greater deficiency of lime wild white tends to disappear.

Proven sires and good breeding dams.—The work on proven dairy sires and good breeding dams is being continued and lists should soon be completed.

MILK UTILISATION.

Mastitis.—During the past year, 366 samples of milk furnished by dairy farmers, milk distributors, creameries and veterinary surgeons were submitted to critical laboratory tests in order to determine the cause of some specific defect, such as unsatisfactory flavour, lack of keeping properties, difficulties of manufacture, or abnormal physical appearance. In some cases faulty flavours and poor keeping quality were clearly associated with external contamination, chiefly of utensil origin. In the majority of the samples, however, the main cause of defective flavours was the incidence of udder disturbances in the producing cows. The majority of creamery samples, and not less than 50 per cent. of individual cow's milk showed evidence of sub-clinical (contagious) mastitis. While *Streptococcus agalactiae* appears to be the chief cause of this disease, staphylococcal infections of the udder are defintely on the increase in South-West Scotland.

Other milk infections.—A Clydesdale farmer found that his milk in spite of the exercise of every care in its production developed an objectionable burnt or caramel flavour within 12 to 18 hours of milking. Laboratory examination showed that the off flavour was due to the presence of a lactic acid coccus. Samples of the pasturage, of the water supply, and of the rinsings of the utensils showed that the specific organisms were not associated with any of these sources. On the other hand, when reference was made to the aseptically drawn milk of individual cows, seven were found to harbour the burnt milk producing organisms within the udder.

Several cases of metallic and oxidised flavours in milk, cream and butter were investigated, the milk utensils proving to be the source of the catalyst.

Cheese discolouration.—The source from which micro-organisms that can cause discolouration in cheese annatto were explored. In so far as the work has progressed, it would appear that cows' faeces, and to a lesser extent, the soil of arable fields contain such discolourising organisms.

Technique of cheese-making.—The manufacture of typical English cheddar cheese (which is distinguished from Scottish cheddar by its creamy white colour, by its thin rind, and by its characteristic texture) has always presented difficulties in North Britain. By the employment of selected strains of *Streptococcus lactis* (isolated from a prize-winning English cheddar of the non-starter type), by controlling the degree of ripeness in the cheese milk, and by minor modifications of the technical process, it was found possible to make some excellent cheeses which possessed all the characteristics of the English cheddar. It was also found that pasteurisation of the primary milk combined with the use of such a selected culture largely eliminated the slight bitterness which is often associated with ripe English cheddar made from naturally fermented milk.

Over 60 cheeses were made this season from the milk of individual farms. Active pure culture starters were used in the manufacture of these cheeses. It was clearly demonstrated that the character of the primary milk has a determining effect on the body and texture of the cheese. It was found that even with the exercise of careful technical control during the manufacturing process, it was not possible to produce a ripe cheese of satisfactory body and texture from the milk supplies of some farms, while that of other farms produced cheeses of first class quality. It was also shown that while pasteurisation is always of advantage in destroying harmful bacteria in cheese milk and in improving the flavour of the manufactured cheese, it will not remedy inherent weakness (mostly caused by udder infections) in the milk itself.

Slow working in cheese caused by bacterial antagonism.—The recent investigations of the Dairy Research Institute in New Zealand have shown that slow working in cheese made from pasteurised milk may be due to the opposing action in the lactic acid fermentation of an organism which itself is a lactic acid coccus. Cultures of this organism were received from New Zealand and its effects determined both by laboratory tests and by actual cheese-making trials. It was found that in raw milk this organism actually stimulated acid production, but that when it was allowed to proliferate in raw milk under favourable temperature conditions for twelve hours and then killed by heat, acid production in the cheese milk (inoculated with starter after pasteurisation) was markedly inhibited. Cheeses made from such infected heat treated milk could not be completed in less than 36 hours, while control cheese made from the same milk, uninoculated, were ready for pressing in a normal time of 9 hours. The cheeses which took 36 hours to make were extremely weak bodied, went out of shape in the curing room and had a brittle, crumbly texture when ripe. The ripe control cheeses on the other hand, were of good body and texture and were normal in other respects.

This New Zealand organism has certain affinities to *S. mastitidis* and, because of this fact, it has been suggested that slow working in cheese-making, so frequently experienced in this country, may be due to mastitis producing bacteria. In order to test this hypothesis, a number of mastitis infected milks were plated out, and pure cultures of the causal organism obtained. Of the strains of streptococci hitherto isolated, not one has been found to exert any restraining effect on the lactic acid fermentation in milk (raw or pasteurised) either under laboratory conditions or in actual cheese-making trials.

Titles of papers issued during the year.

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2. McCandlish, A. C.: Proteins for cows. *Ayrshire Cattle Soc. J.*, **6**, 1, 20, March, 1934.
3. ———: Rearing for the dairy herd. *Farmer and Stockbreeder*, **48**, 2328, 1199, 1934.
4. McCandlish, A. C., and Black, A. N.: A register of proven Ayrshire sires. *Ayrshire Cattle Soc. J.*, **6**, 2, June, 1934.
5. McCandlish, A. C.: Feeding for milk production. *Rep. Scott. Milk Rec. Assoc.*, 1933, 75, August, 1934.
6. ———: Carbohydrates for cows. *Ayrshire Cattle Soc. J.*, **6**, 3, 108, September, 1934.

7. McCandlish, A. C.: The management of dairy cows. *Trans. Northumberland Agric. Discussion Soc.*, 4, 18, September, 1934.

8. Leitch, R. H.: Arrested lactic acid fermentation in cheese-making. *Hansen's Dairy Bull.*, **18**, 11 and 12, 1934.

9. ———: Dairy hygiene. *Milk Trade Gaz.*, 17th October, 1933.

10. ———: Quality in cheese. *Galloway Advertiser*, 22nd February, 1934.

11. ———: Cultured butter milk. *Scott. Milk Trade J.*, **1**, 2, 6, 1934.

12. ———: Dunlop cheese and its manufacture. *Scott. Agric. Publishing Co.*, 1934.

13. ———: Cream. *Milk Trade Gaz.*, **7**, 99, 2, 1934.

14. ———: Bacteria in raw and pasteurised milk. *Scott. J. Agric.*, **17**, 2, 166-172, 1934.

15. ———: Burnt or caramel flavour in milk and its products. *Ibid.*, **17**, 3, 293, 1934.

16. ———: Cottage cheese and buttermilk cheese. *Scott. Milk Trade J.*, **1**, 3, 9, 1934.

17. ———: Clotted cream and its preparation. *Ibid.*, **1**, 4, 9, 1934.

ECONOMICS

115. ABERYSTWYTH : UNIVERSITY COLLEGE OF WALES

Agricultural depression.—From accounts for an unchanging group of farms over four years a measurement of the recent depression on the basis of conditions in 1930-31 has been obtained. In the base year the average gross income amounted to £170, and after allowing for wages to relatives it allowed £126 for capital and management. For the two following years gross income was insufficient to provide wages for family labour, and in both capital was depleted. Some recovery was shown in the last year, and after allowing for family labour and interest on capital, an average sum of £23 was available for management as compared with £70 in the base year (1).

Higher farming and incomes.—A statistical study of relationship between inputs of labour, raw materials, and profits confirms results of previous study that increase in intensity of production is followed under contemporary conditions in Wales by higher earnings. There is a close relationship between output and income : the farmers obtaining the higher incomes worked their holdings most intensively. Relations between output per acre and rent of land, or productivity of land and its rents, are not very close. Where heavy expenditure on labour is incurred each additional increment of raw materials is accompanied by relatively large increase in output, and labour is used to greatest advantage on the most intensively worked holdings. But the highest simple coefficient of correlation ($r = + 0{\cdot}88$) is found between raw materials (feeds and fertilisers) and gross output. Success has followed the efforts of those farmers who have adjusted expenditures in ways which enable them to avoid a diminishing return on labour input, and they have done this by increasing the proportions of expenditure on raw materials to cost of labour (10).

Characteristics of Welsh farming.—Organisation of farming in Wales is largely of " family farm " character. Its social characteristics are—low incomes ; narrow range of incomes from high to low, or relatively even spread ; a relative absence of economic and social distinctions ; little fixity of economic and social status. In spite of the small size of farms and the characteristic form of organisation, technical efficiency is rising. A fairly high proportion of workers rise to the status of farmers. The evenness of spread of wealth, low degree of variation from crude average of income, and the economic flexibility of the system as regards personnel, create conditions which are socially satisfying. Yet the agricultural community does suffer from low incomes, especially as regards command of modern forms of "services" of which cost is high because of scatter of population (2, 3).

Milk consumption.—A study of milk consumption has been carried out in four social-class districts of the City of Cardiff, namely, "good middle class", "good working class", "new housing area" and "poor working class".

In poor working class households, 21 per cent. of children 7-14 years, and 24 per cent. of those under 7 years did not obtain any fresh milk at home. Even in good working class households 10 per cent. and in the new housing area households 11 per cent. were dependent on skimmed condensed (12). Further study of a distressed area in South Wales (Rhondda Valley) revealed that of a total of 602 households 499 purchased liquid milk, 4 did not obtain any sort of milk, while the remaining 99 purchased only the condensed variety. Of the total households only 208 purchased cream.

Milk retailing by producers.—The mileage travelled in retailing a gallon of milk has been found to vary between one half-mile for daily rounds of 39 gallons upwards, to 1 and ¼th miles for rounds of less than 19 gallons. The time required for delivery of one gallon varied between 18 minutes for the largest and 36 minutes for the smallest rounds, with consequent variations in labour costs between 2·2d. and 4·4d. per gallon. Total costs of retail delivery averaged 4·41d. per gallon with a variation between 3·9d. and 6·65d. for the groups of largest and smallest rounds (11).

Co-operative trading under depression.—A study of financial results of farmers' co-operatives in a period of falling prices yielded these results: High ratio of stocks carried to yearly turnover is a source of weakness, and societies showing losses carried much higher stocks than those making profits. Farmers' demand for credit makes depression trading more difficult, and while the general proportion of credit sales to total was rising the societies with the lowest profits and losses were allowing the highest amounts of purchasers' credit. The most difficult adjustments in depression are those relating to labour costs and charges for borrowed capital. While actual volume of goods turnover per employee increased the cash turnover per employee diminished, and capital charges per £1,000 cash turnover increased. Thus while wider margins of gross profit were required, there was difficulty in obtaining them, net profits diminished and proportion of societies showing losses increased (9, 16).

Titles of papers issued during the year.

1. Ashby, A. W.: Efficiency in dairying and some economic results. *J. Brit. Dairy Farmers Assoc.*, **46**, 32-48, 1934.
2. ———: Planning Welsh agriculture: Some basic considerations. *Welsh Housing and Development Yr. Bk.*, 1934.

3. Ashby, A. W.: Some characteristics of Welsh farming. *Welsh Outlook*, **20**, 11, 1933.
4. ———: Planning agriculture: Some preliminary observations. *J. Proc. Agric. Econ. Soc.*, **3**, 3, 125-138, 1934.
5. ———: The social purpose of adult education: its relation to the improvement of rural social life. (Department circular.)
6. ———: The necessity of the milk marketing scheme. *Home Farmer*, **1**, August, 14-16, 1934.
7. Ashby, A. W., and Howell, J. P.: The outlook for farming in Wales. *Y Cymro*, Wrexham, January, 1934.
8. Davies, J. Ll.: The diary of a Cardiganshire farmer, 1870-1900. *Welsh J. Agric.*, **10**, 5-20, 1934.
9. Williams, J. G., and Davies, Miss D. A.: Agricultural co-operative societies in Wales: A review of three years' trading in farm requisites, 1930-31-32. *Ibid.*, **10**, 20-38, 1934.
10. Jones, W. H.: A statistical analysis of farm accounts. *J. Farm Economics*, **16**, 4, October, 1934.
11. Jones, W. A., and Cowie, W. J.: Retailing of milk by producers in the Cardiff area. *Welsh J. Agric.*, **10**, 61-83, 1934.
12. ———: The consumption of milk in Cardiff. *Ibid.*, **10**, 83-107, 1934.
13. Harry, E. Ll.: Recommendations of Commission on Livestock Marketing. *The Glamorgan Farmer*, July, 1934.
14. Morris, S. T.: Cattle-raising by "suckling" in Radnorshire. *Welsh J. Agric.*, **10**, 108-126, 1934.
15. Jolly, A. L.: A comparative study of production on farms in the Welshpool district of the Severn Valley for the years 1919 and 1932. *Ibid.*, **10**, 38-60, 1934.
16. *Reports of Conferences on Development of Agricultural Co-operative Business, Aberystwyth*, October, 1933, and May, 1934. Issued by the Department.
    Contents:
    - Co-operative wool marketing.
    - Review and forecast of the trade in feedstuffs.
    - The fertiliser market, 1932-33.
    - Farmers' production policies under the marketing schemes (pigs and milk).
    - Overproduction and underconsumption in relation to agricultural markets. (Jones, A.)
    - Collective life assurance of members of farmers' co-operative societies. (Williams, J. G.)
    - Livestock marketing proposals and trade in Welsh stock. (Ashby, A. W.).
    - Some recent problems of management in co-operative societies. (Jones, W. H.)

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116. BRISTOL UNIVERSITY

Willow survey.—In the Spring of 1934 a survey was made of the willow growing industry in the valleys of the rivers Severn, Avon and Stour. Generally speaking, the inquiry showed that the varieties of the willows grown and the system of cultivation differed very considerably from those of Somerset.

Management for milk production.—The enterprise study of methods of management for milk production was continued for a second year. The results of the first year's inquiry have been published (1). Twenty-four, farms carrying 891 cows, are covered by the report, which is chiefly concerned with types and methods of feeding in relation to milk yields.

Poultry farming.—The period under review also saw the completion of the second year of the enterprise study of poultry farming. The first report has been issued (2). It briefly examines the position of the poultry industry from a national standpoint, and then proceeds to a detailed study of local conditions as shown by the records obtained from twenty-four specialist poultry farms.

Financial accounts.—Well over one hundred financial accounts have been analysed and reported upon.

Titles of papers issued during the year.

1. Dawe, C. V.: An inquiry into management for milk production. *Bristol U. Bull.*, 11, 1934.
2. Dawe, C. V., and Nutt, J. D.: An economic survey of the poultry industry. *Ibid.*, 12, 1934.

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117. CAMBRIDGE UNIVERSITY

Economic survey.—The principal activity again centred round the economic survey of the Province which was commenced in 1931. The six counties of Norfolk, Suffolk, Essex, Hertfordshire, Cambridgeshire, and Huntingdonshire were included and sampling was on lines similar to those previously adopted. The co-operation of nearly 1,200 farmers was secured and a number of County Organisers gave assistance.

In addition to size classification, the records were also subdivided according to geographical " districts ", based primarily on soil types and marketing facilities. Quantitative measurements of the variations between one " district " and another have been obtained and a study made of the factors affecting profitableness of farming within each district. A full report of the survey was published in July, 1934 (11, 12).

Special investigations and studies.—The special investigations into the cost of milk production in Cambridgeshire, and of wheat growing costs in the Province, have been completed (4, 5). As a result of experience gained in the former enquiry, a food recording scheme for dairy cows for the Province was organised in May, with a commencing membership of 40 farmers. The willow growing industry in the Province was the subject of a special study.

Special studies on small holdings (6) and on mole drainage (10) problems have been made from the data collected during the survey.

Account book.—A special account book has been designed for the use of farmers in the Province.

Titles of papers issued during the year.

1. Carslaw, R. McG.: Forecast of wheat acreage in 1934. *Farm Economist*, **1**, 95-96, 1934.
2. ———: The agricultural geography of the Eastern counties. *Agric. Prog.*, **11**, 70-76, 1934.
3. ———: Britain's poultry supplies and demand. *Husbandry*, **4**, 4, 1934.
4. Carslaw, R. McG., and Jolly, A. L.: Variations in the cost of wheat growing. *Farm Economist*, **1**, 105, 1934.
5. Jolly, A. L.: Milk producer-retailers' profits. *Ibid.*, **1**, 163, 1934.
6. Menzies Kitchin, A. W.: Some aspects of small holdings in the agricultural structure. *Econ. J.*, **44**, 657, 1934.
7. ———: The influence of price fluctuations on consumer demand. *Farm Economist*, **1**, 141-143, 1934.
8. ———: Pig keeping in the Eastern counties. *Nat. Pig Breed. Ann.*, 68-72, 1933-34.
9. ———: Pig recording and efficient production. *Yr. Bk. Cent. Council Milk Rec. Socs.*, 1933.
10. Nicholson, H. H.: The durability of mole drains. *J. Agric. Sci.*, **24**, 185-191, 1934.
11. An economic survey of agriculture in the Eastern counties, 1933. Report No. 22. *Farm. Econ. Br., Dept. Agric., Camb. U.*
12. Financial results of farming in the Eastern counties of England. (Preliminary statement for 1933). *Farmers' Bull.* No. 3, Farm Econ. Br., Dept. Agric., Camb. U.

118. HARPER ADAMS AGRICULTURAL COLLEGE

Poultry management study.—The fifth accounting year started on 1st October, 1934, and it is felt that our investigation into the economics of egg production has gone as far as it usefully can at this stage. As was mentioned in last year's report, the Department has been experimenting with method in order to arrive at a scheme for examining hatching and rearing costs. It is felt that many general farmers are driven into the hatching and rearing business by the high cost of replacement stock, and since they are neither technically nor temperamentally equipped for this highly skilled business, do their share in reducing the standards of laying stock. A small investigation was conducted, on similar lines to that reported last year, on the cost of pullet production; the results showed that the net cost per bird was 3s. 3½d. with farm incubated chicks and 4s. 0¾d. with bought chicks.

Sugar beet.—The Department again costed 1,000 acres of sugar beet in the area. It has been felt here for a long time that one of the factors which must influence the farmer to continue to grow the crop, when the subsidy period is definitely over, is the effective use of by-products. A method for arriving at the value of tops to the individual farmer for the purpose of comparative report has been in use in the Department for the last seven years. It has been assessed that the value of the tops if fed to sheep would be about 18s. per ton.

Milk.—The 14 farms who have been co-operating in the milk management study continue to keep records, and the latter part of the year was occupied in selecting the necessary farms to co-operate in the milk study inaugurated in October in which these farms have now been merged.

119. LEEDS UNIVERSITY

Farm management.—Detailed accounts of some 60 farms of various type and size are still being kept and carefully examined, the grading up in farm management of many of these being striking.

Agricultural history.—The eight years' work on the study of the agricultural development of Hooton Pagnell has now been completed and published (1), and the reviews as far as they have been received have been distinctly encouraging.

Research in management for milk production.—The work in this direction has received added impetus through the action of the Milk Board, and we have now 80 co-operators including 48 in the West Riding (7,000 milk producers), 19 in the North Riding (2,000 milk producers), and 13 in the East Riding (1,600 milk producers).

Poultry management investigation.—The Department is now falling definitely into line with the joint scheme, originally instituted at Harper Adams, and the co-operation of some 36 poultry keepers in different parts of the county has been enlisted.

Complete investigations.—The following investigations have now been completed, and are in process of being written up for publication :—

(*a*) An agricultural survey of Nidderdale.
(*b*) An agricultural atlas of Yorkshire.
(*c*) The economics of the production and disposal of peas for picking green.
(*d*) The rise and fall in the flax industry of the county.
(*e*) The economic position of the potato crop.
(*f*) A survey of the system of sheep management in the county.
(*g*)Beef, the economics of its production and disposal.

Other work.—The agricultural survey of Airedale is now nearly completed, and a comparison between the variations in the agricultural systems of the two dales similar in physical but differing in marketing conditions is proving exceedingly interesting.

Title of paper issued during the year.

1. Ruston, A. G., and Witney, D.: Hooton Pagnell. The agricultural evolution of a Yorkshire village. E. Arnold & Co., 1934.

120. MANCHESTER UNIVERSITY

Management for milk production.—The progress made by the farmers in the improvement of their pastures and meadows has been very marked during the year. The object of the work, the reduction of the cost of producing milk, has made a much more definite and practical appeal to them, and may be said in some districts to have become infectious. There has been a considerable accession to the number of men keeping records of their progress in this respect, but the influence of the visible improvements they have made is much wider than the scope of the records. There is, also, an advance in other directions. Men who began with simple records of feeding have asked to be taken on to a system of more complete costs, and are ready to apply the principle to any branch of their farming.

Potato and corn production.—The same principle applies as much to potato and corn growing as to milk production. On a much smaller scale it has been adopted by West Lancashire and Cheshire arable farmers. Expenditure on seed potatoes and on fertilisers for both crops is the subject for investigation and experiment on a few farms. The task seems inherently more difficult than it is with milk producers, but there is wide field for work.

Title of paper issued during the year.

1. Orr. J.: Management for milk production. *Bull. No.* 2.

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121. MIDLAND AGRICULTURAL COLLEGE

Costings.—The complete cost accounts on two farms—one arable and one mixed dairy farm—are still continued. The difficulties of arable farming have been such that a satisfactory policy has not yet been attained on the arable farm. On the dairy farm, however, an appreciable improvement in economic production has been effected during the period in which the farmer has been collaborating with the Department. Milk cost 13s. 9d. per gallon to produce in 1928, 9s. 1d. in 1932 (the lowest figure reached), and 9s. 7d. in 1934.

Financial accounts.—The accounts are supervised by the Department, analysed and balanced at the end of the accounting year and each farmer receives a brief report in which any apparent weaknesses in his farming system are indicated. Of the 47 farms co-operating 38 are in Derbyshire, 6 in Leicestershire, 2 in Lindsey, and 1 in Nottinghamshire.

Potato production and marketing.—This investigation, covering all the costs incurred by the grower in the production and marketing of both early and maincrop potatoes over a period of two years, has now been completed and a general report on the results is in the course of preparation.

Potato distribution and consumption.—Arising out of the enquiry into potato production and marketing, a study of retail distribution and consumption was completed during the last year. This investigation was undertaken with the following objects :—

(*a*) To arrive at an approximate measure of consumption per capita.

(*b*) To ascertain how consumption is affected by occupation or by income limitations.

(*c*) To indicate the direction of consumer preferences.

(*d*) To collect evidence of any change in the rate of consumption and reasons for the change.

(*e*) To examine briefly the economy of existing channels of retail distribution.

(*f*) To enquire if any change is desirable in the condition in which potatoes are offered to the retailer.

Since it appeared likely that potato consumption would be greater in an agricultural area than in an industrial area it seemed desirable that data should be collected from districts that could be classed under those separate heads for comparison. With this end in view a survey was made of potato consumption throughout the whole of the agricultural town of Brigg in north Lincolnshire and throughout selected districts in the City of Nottingham. The study of retail distribution and economy was confined to the town of Brigg.

The results of this enquiry will be incorporated in the final report on potato production and marketing now in the course of preparation.

Meat and milk consumption.—Advantage was taken of the facilities offered by the potato consumption enquiry in Nottingham to obtain similar data relative to meat and milk consumption. It is proposed to analyse the information on meat consumption with particular reference to the results of the Loughborough meat consumption survey of 1930, and to draw comparisons where permissable. Data were collected in connection with these enquiries in Nottingham from many classes of consumers.

Research in management for milk production.—This investigation has been continued and amplified and a second report has been prepared for issue to co-operating farmers and others interested (3). The enquiry during the past year has been focussed upon two of the most important factors in milk production economy, i.e. feeding economy and herd maintenance charges. The method adopted in the preceding year, by which the efficiency of grassland was measured by its contribution to the starch equivalent requirements of the herd, has again been utilised.

Willow growing.—The enquiry into willow cultivation in the valleys of the Trent and Soar (2) show that the industry is passing through a serious depression, that the acreage under cultivation is less than half the area cultivated in 1914, and that the industry in this area is now in the hands of about 30 growers. The standard of cultivation is now very low.

High labour costs coupled with low prices for rods appear to be the chief causes of the depression and the application of modern scientific principles to rod cultivation seems to be essential if the industry is to be re-established.

Sugar beet costs.—Such costings as were undertaken under this head arose through request by the grower and were mainly a result of the interest aroused by the potato costings in Lincolnshire.

Titles of papers issued during the year.

1. Jones, A., and Makings, S. M.: Potato production costs—Maincrop 1933. *Farmers' Bulletin No.* 6, 1934.
2. Jones, A., and Heath, W. E.: Willow growing in the valleys of the Trent and Soar.
3. Heath, W. E.: Some aspects of herd management for milk production. *Farmers' Bulletin No.* 7, 1934.

122. NEWCASTLE: ARMSTRONG COLLEGE, DURHAM UNIVERSITY

Poultry management survey.—The investigation of the economics of poultry enterprises has continued to be the main work during the year under review. At the commencement of the year it was found possible to extend the scope of the study to include 47 enterprises, and out of these, 41 complete records were obtained.

This project has now been pursued for a period of four years. Throughout this period close collaboration with the Advisory Economist in the West Midland Province has been maintained, and, during the last two years this collaboration has been extended to include the Bristol Province. Since the period has been marked by a persistent fall in the prices of eggs and poultry, and in the last two years, by an appreciable rise in the poultryman's main item of cost, i.e. feeds, the records from the two provinces have provided a valuable measure of the gradual worsening in the economic status of the commercial egg producer. Moreover they enabled the advisers concerned to submit important evidence to the marketing Reorganisation Commission for Eggs and Poultry, and further, they will make a valuable contribution to the problem of land settlement which is now being seriously canvassed in many quarters.

The results, which confirm those obtained in previous years, are as follows :—

(*a*) An extraordinarily wide range in profitability on individual enterprises.

(*b*) Extreme variations in flock performance as measured by average egg production.

(*c*) The critical importance of the price of feeds, which are easily the main item of costs.

(*d*) The significance of falling egg and poultry prices as a factor mainly responsible for the adverse trend in poultry farming profits, and

(*e*) The high rate of mortality which occurs in many commercial flocks.

Other investigations.—Preliminary steps have been taken to institute a study of milk production costs on similar lines to the poultry investigation, and an inquiry into the economic status of the smaller agricultural holdings in the province.

123. READING UNIVERSITY

Middlesex survey.—The field work for this survey was completed in January, 1934. All occupiers of land in the county who completed the annual returns for the June Statistics in 1932, who could still be traced, were visited. For unforeseen reasons, however, the analysis of the data collected has had to be held up for the time being.

Willow growing in the Kennet Valley.—This survey was carried out in February and March, 1934, and a mimeographed report was issued (4). Every grower of osiers in the district was visited and information was obtained about methods of production and marketing. The survey corroborated the generally held opinion that the industry is in a decadent state, the two chief contributory factors being the collapse of the market and the exorbitant labour cost where all operations have to be carried out by manual labour.

Blackmore Vale dairy farms.—This investigation is now in its fourth year, 15 farmers having co-operated from the beginning. A report on the results of the third year (Lady Day 1933-34) was issued in July, 1934 (5). This report showed that when no charge was made for family labour all farms made a surplus income, the average "family income" being about £183, as compared with £154 in 1932-33 and with £63 in 1931-32. When family labour was charged at current wages rates only eight farms showed profits and seven farms showed losses—the over-all average profit from the 15 farms being £21 12s. 10d. per farm or 4s. per acre.

Hampshire dairy farms.—Accounts similar to the above have been kept by four Hampshire dairy farmers for the year ended Michaelmas 1934. All four farmers are members of the North East Hants Agricultural Association which asked the Department to undertake the work.

Hampshire strawberry growers.—This enquiry is now in its fifth year. A report for the fourth year, dealing with the 1934 crop, was issued early in October, 1934. This report is based on records kept by 41 growers. These growers had between them 121·5 acres under strawberries, and their total sales off the 1934 crop were 139·22 tons. When no charge was made for family labour there was a " profit " of £32 7s. per acre or 3·03d. per lb. of fruit sold. When, however, family labour was charged at current wages rates the " profit " per acre was only £13 9s. 5d. and " profit " per lb. was 1·26d. Each grower was supplied with a comparative efficiency table in which his results were compared with the average results of all 41 growers and also with the average of the 13 growers with highest profits. These thirteen growers owed their superior position to higher yields per acre and to higher prices per pound; they had also higher costs of production especially for manures used. This report has been submitted to the Swanwick and District Fruit Growers' Association and, as in previous years, will be incorporated in their annual report.

Cost accounts.—Complete cost accounts were kept on four farms: one arable-sheep farm, two mixed arable and milk-selling farms and one cheese-making farm. The accounts for these farms are now available for many years. During the past year interesting changes occurred on two of the farms. On the arable-sheep farm a dairy enterprise was introduced for the first time, while on one of the mixed farms a combine-harvester was purchased. The influences of these innovations on the farming systems are being watched closely.

Investigation into management for milk production.—This enquiry which is being conducted jointly by all Advisory Economists is being worked at this centre in conjunction with the Blackmore Vale farmers who are co-operating in the financial accounts project (5).

Study of agricultural price records.—This study has been completed. After a short historical introduction on agricultural price records, the work gives a general review of price recording with particular reference to official price records, broadcast prices, and price recording in the national and local press. Perhaps the most important part of the work is to be found in the series of appendices, particularly the following indexes :—

Prices derived from the Agricultural Market Report.
Prices derived from other sources.
Statutory corn prices in the London Gazette.
Statutory corn prices reprinted in official publications.
Prices in the national and local press.
Agricultural periodicals.

It is hoped that it will be possible to publish portions of this study.

Titles of papers issued during the year.

1. Bissett, G. B.: Financial results of strawberry farming in Hampshire in 1933. *Financial Accounts Studies*, 4.
2. ———: Financial results of strawberry farming in Hampshire in 1934. *Ibid.*, 6.

3. Thomas, E.: Agricultural marketing schemes and the small producer. *J. Women's Fm. & Gdn. Assoc.*, 12-18, 1934.
4. Thomas, E., and Bissett, G. B.: Willow growing in the Kennet Valley. *Miscellaneous Studies*, 1.
5. ———: Financial results of dairy farming in the Blackmore Vale, 1933-34. *Financial Accounts Studies*, 5.

124. SEALE-HAYNE AGRICULTURAL COLLEGE

Financial accounts.—The accounts of 106 farmers for the year 1932-33 covering an area of 23,519 acres, have been collected and have been or will be reported on. The analysis has been carried out in the usual way, and a general report similar to that of previous years will be issued.

Account keeping.—In addition to the considerable number of farmers whose books are closed yearly by the department, assistance was given to 6 farmers who were keeping books for the first time. All these were farmers who had participated in one or other of the book-keeping correspondence courses.

Mention was made last year of the growing numbers of farmers whose books are closed by the department compared with those who supply summarised information through their accountants. The advantage of the former method in supplying data from farms representative of the more normal types of farming was stressed. Another advantage which was apparent last year, but has been demonstrated much more clearly this year, is that the information becomes available much earlier where it is supplied by the farmer direct to this department, without an accountant as an intermediary.

Labour requirements of crops and stock in Devon and Cornwall.—This investigation, which has been running since 1929, was completed and a report (1) was issued.

Feeding stuffs investigation.—The first year of this investigation closed in 1932. The farmers co-operating in this work were invited to continue the records for a second year, but, as reported last year, the response was only partially satisfactory. Nine farmers completed the recording for the second year. This enabled a comparison to be made of the foods fed during the two years, and a farmers' report (6) was issued showing the variations in foods fed, milk produced, and bacon or pork sold.

This investigation was initiated before the scheme for research in milk production had been decided on by the majority of the advisory economists and jointly undertaken by them. For this reason it differs from it in some particulars, especially in providing details of foods fed to stock other than dairy cattle.

In May, 1933, as noted in last year's report, a number of milk recording farmers from all over Devon and Cornwall agreed to keep similar records to those kept by the West Cornwall farmers. Their initial enthusiasm, however, considerably exceeded their staying powers, and only 8 provided complete usable records. Six of these eight agreed to continue the work for a second year. With such a small number of farmers completing the first year's investigation, and these scattered throughout the two counties, it was not thought possible to produce a report on this work. Each farmer who co-operated received a confidential report on his own results, all of which were contrasted with the West Cornwall averages.

Movements of farmers, land tenure, and rent changes.—No comprehensive report on this study has been published, but it has provided the background for several short publications.

Recent alterations to the permanent equipment on South Devon farms.—A report, based on a survey made during 1934 of the permanent equipment of 178 farms in South Devon, has been published (7).

A survey of the sheep industry in Mid Devon.—A very mixed system of farming is followed in the Mid Devon district round Exeter. With 30 per cent. of the land under the plough and much of the tillage worked for the production of a malting sample of barley, it is understandable that arable sheep farming assumes a good deal of importance in the farming system. Apart from the place which sheep take in the general economy of the system, special attention is being paid to the relative importance, advantages, and disadvantages of fat lamb production compared with the more traditional system of "hogging." Sixty farmers have been visited, while the history of the sheep industry in this area during the last 10 years has been carefully studied by means of the financial accounts which have been collected from farmers in the area.

Titles of papers issued during the year.

1. Long, W. H.: The value of physical data in farm management problems. *J. Proc. Agric. Econ. Soc.*, **3**, 1, 40-50, 1934.
2. ————: Factors affecting some types of farming in Devon and Cornwall. *J.R.A.S.E.*, **94**, 42-61, 1933.
3. Long, W. H., and Daniel, C.: The value of farm produce consumed in the farm house. *J. Min. Agric.*, **41**, 1, 29, 1934.
4. ————: The profitability of cattle and sheep farming in 1932-33. *Farm Economist*, **1**, 6, 1934.
5. Long, W. H., and McCann, N. F.: Labour requirements of crops and stock in the South-West. *Seale-Hayne College Pamphlet*, No. 41, Jan., 1934.
6. Long, W. H., and Morris, S. T.: A two years' comparison of foods fed to livestock in West Cornwall. *Farmers' Report*, No. 8, March, 1934.
7. MacGregor, J. J.: Changes in permanent equipment of South Devon farms. *Seale-Hayne College Pamphlet*, No. 43, Sept., 1934.
8. ————: Economic changes on Devon and Cornwall estates. *Estate Mag.*, **34**, 342-347, May, 1934.
9. ————: Recent land tenure changes in Mid Devon. *Economica*, 459-472, Nov., 1934.
10. ————: Changes of occupiers on Mid Devon farms 1912-32. *Farm Economist*, **1**, 5, Jan., 1934.
11. ————: Changes in rents of Mid Devon farms. *Ibid.*, **1**, 7, July, 1934.

125. WYE: SOUTH-EASTERN AGRICULTURE COLLEGE, LONDON UNIVERSITY

Farming costs of production and financial results.—This investigation has been continued on the same lines as in previous years. Evidence is accumulating regarding the practical value of detailed accounting to the farm manager. There is a growing demand for what may be called purely advisory services from farmers who are prepared to do most of the analytical work themselves but who do not know the most suitable procedure. This demand has been created by means of the reports which have been published on the results of the above mentioned investigation (2).

Food-recording scheme for dairy cows.—The most striking feature about this scheme is the marked unwillingness to discontinue it which has been shown by the majority of the co-operating farmers. No better evidence than this can be found of the cumulative value of work of this kind. It is the comparisons from year to year on the same farm which are undoubtedly of most direct value to the farm manager.

Food-recording scheme for pigs.—This scheme is now in its second year but owing to the pressure of other work it has not been possible to develop it according to the original plan. It is still largely in the experimental stage. The essential difficulty in getting complete results is the lack of proper weighing facilities for the pigs and it has not been easy to get definite, concrete evidence as to the financial benefits to be derived from systematic weighing of the pigs. Until such evidence can be obtained in a few typical cases, progress will be slow.

Canning peas investigation.—This investigation has been continued for a second year. It is felt however that since the seasons of 1933 and 1934 were very much alike no conclusions can be drawn until results are available for a greater variety of seasons. It is hoped to continue the investigation until such results are obtained.

Poultry investigation.—Some time during 1933 the County Poultry Instructor for East Sussex expressed a wish that East Sussex should be included in the Poultry Investigation which was initiated several years ago by the Advisory Economist at Harper Adams Agricultural College. Plans were made to commence operations at 1st October, 1933, and the County Poultry Instructor undertook to obtain the co-operation of the requisite number of poultry farmers. The response was very disappointing. More than half of those who agreed to co-operate withdrew, and ultimately only four poultry keepers completed the returns for the full year. It is not proposed to go further with this investigation in the meantime.

Glasshouse investigation.—During 1933 the Advisory Economist was invited by the Worthing Glasshouse Growers to discuss with them the possibility of making an investigation into the financial position of the glasshouse industry in that area. Several meetings were held and a detailed plan of operations drawn up. This received the full approval of the growers' executive committee but ultimately less than half a dozen growers agreed to co-operate in the investigation, which was thereupon abandoned. The Advisory Economist succeeded in gaining a most valuable insight into the conditions of the glasshouse industry in this area.

Titles of papers issued during the year.

1. Wyllie, J., and Hewison, N. V.: Financial results on the College farms. General financial results for six years, 1926-27 to 1931-32. *S.E. Agric. Coll. Rep.*, 18, 123-157, 1933.
2. Wyllie, J.: Investigation into farming costs of production and financial results. Milk production: Five years' costs and financial results, 1928-29 to 1932-33. *Ibid.*, 19, 97-136, 1934.
3. ———: Research in agricultural economics. A ten years' retrospect. *J. S.E. Agric. Coll.*, **34**, 9-18, July, 1934.
4. Knox, M. A.: Rate of turnover as a factor influencing farm profits. *Ibid.*, **34**, 19-23, July, 1934.
5. Knox, M. A., and Prowse, I. B.: A method of estimating the starch equivalent of meadow hays. *Ibid.*, **34**, 227-231, July, 1934.
6. Wyllie, J.: The use and abuse of farming records. *Trans. Yorks. Agric. Soc.*, **91**, 27-34, 1933.
7. ———: The economist in the cowshed. *Kent Milk Rec. Soc. Yr. Bk.*, 32-35, 1933.

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126. ABERDEEN: NORTH OF SCOTLAND COLLEGE OF AGRICULTURE

Financial accounts investigation.—The investigation into the "Profitableness of Farming in Scotland" is a permanent feature in the research work and is carried on in collaboration with the Department of Agriculture for Scotland. The results are presented in a Department publication. Records are now being collected from all counties on the mainland and from Orkney and Shetland.

For the crop year 1932-33 three reports were issued dealing with the financial results of three main types of farming practised in the area. These results indicated that on the mixed arable farms (reports 1 and 2) the improvement shown in 1931-32 had not been maintained owing to the recurrence of low prices for oats and potatoes and the continued decline in the price of fat cattle. It was again apparent that farms which were so organised that labour was utilised on direct production to its fullest extent by means of so called side-line enterprises were above average in financial returns, whereas those farms dependent almost entirely on fat cattle and grain were below average.

The financial records for the crop year 1933-34 have been collected and the analysis of the results is in progress.

Poultry investigation.—The number of poultry accounts has been increased and the analysis of the results for the year 1933 showed, that on the average, the net return to the poultry keeper had decreased slightly, but that where the organisation was attended to in a businesslike manner, and disease avoided, profits usually resulted.

Cost accounting.—A limited number of cost accounts were kept in order that detailed figures on the cost of production of certain products might be available.

Titles of papers issued during the year.

1. Imper, A. D.: Report on financial accounts, Group I. (Cattle feeding.)
2. ———: Report on financial accounts, Group II. (Cattle rearing.)
3. ———: Report on financial accounts, Group III. (Dairying.)

All circulated privately

4. ———: Profitableness of poultry enterprises, 1933. *Aberdeen Press & Journal*, 14th May, 1934.

127. EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE

Farm accounts investigation.—The study of the three groups of farms is being continued, the number of accounts analysed continuing to show a steady increase. The analysis of the records for the year 1932-33 (covering the 1932 crop) emphasises the intensity of the agricultural depression from which farmers have been suffering throughout the whole area from which the accounts are drawn.

> (i) *Fourteen East of Scotland farms.*—The past year proved a disastrous one, far worse than any of the three previous years, and although four farms out of the fourteen still contrived to show profits, five farms, on the other hand, had net losses exceeding 30s. per acre, the principal factors underlying this deplorable farming year being the phenomenally low prices ruling for the 1932 potato crop which coincided with a renewed fall in the price of wheat, barley, and oats, and a further shrinkage in the already narrow margin of gross profit on fat cattle.
>
> (ii) *A group of farms of arable sheep type.*—For these farmers the past year proved disastrous, but little better than the year 1931-32 which was the worst on record, the collapse of sheep prices proving so serious that only two farms showed a return equal to 5 per cent. on capital invested, whilst four showed losses of over 30s. per acre.
>
> (iii) *Six border semi-arable sheep farms.*—As in the case of the arable sheep farmers, these men experienced but a slightly better year than 1931-32.

Smallholdings accounts investigation.—The extension of advisory work in connection with smallholdings has been enlarged, and during the year 1932-33, the accounts of 13 smallholdings were studied, 7 being dairy holdings and 6 mixed holdings, whilst 5 of them are demonstration holdings in receipt of a monetary grant from the College for the purpose of educational and experimental work.

The dairy holdings showed an average profit of £118 per holding, whilst the mixed holdings showed a profit of £97. Taken altogether, smallholders were fully £1 per week worse off than two years previously—a large slice out of their total income. Moreover, their financial returns are insufficient to cover 4 per cent. interest on their capital invested and to give them a wage of 35s. per week which can only be regarded as very inadequate remuneration for the interminable and arduous work of the smallholder and his wife.

A beginning has also been made with the investigation of accounts of a number of specialist poultry farmers, and this work is extending.

To each farmer co-operating in the Accounts Service was issued a detailed report concerning the result of his own farm, together with a general report summarising the conclusions suggested by analysis of the records of the farm group. General reports were circulated also to all co-operating farmers and to a wider public embracing fellow-economists and others interested in the work.

Potato information service.—This service, inaugurated in November, 1932, in order to give farmers in the East of Scotland prompt and accurate information regarding the tonnage lifted and the condition of the Scottish potato crop, as well as its movement into consumption at various stages of the selling season, was continued. The information, obtained from some 400 representative potato growers in Angus, East Perth, Fife, and the Lothians, was co-ordinated with the general potato position and prospects in the whole country, and two reports were issued regarding the 1933 crop (4, 5). In view, however, of the inauguration of the Potato Marketing Board for Great Britain, which will no doubt conduct a comprehensive Intelligence Service in the interests of potato growers throughout the whole country, it was felt that our own activities would be unnecessary and this branch of our work was accordingly discontinued, at any rate for the time being, during Spring 1934.

Titles of papers issued during the year.

1. Witney, D.: 32 arable and semi-arable farms in the East of Scotland in 1932-33.
2. ————: 21 Border semi-arable sheep farms and six Border high ground sheep farms in 1932-33.
3. ————: 13 East of Scotland smallholdings in 1932-33.
4. ————: Potato information service: Autumn report on 1933 crop.
5. ————: Potato information service: Mid-season report on 1933 crop.
6. ————: Memorandum on cost of production of eggs in 1932-33.
7. ————: Scottish milk marketing scheme: effect on smallholders.

Circulated privately.

8. ————: Economic aspects of land tenure (Reprinted from Factors' Magazine).

128. GLASGOW: WEST OF SCOTLAND AGRICULTURAL COLLEGE

Farm accounts.—Roughly 100 financial accounts from general farms and poultry farms, including a small number obtained by the courtesy of a practising farm accountant in the area, were completed during the year, and where suitable, put into the form required for the " Profitableness of Farming in Scotland " report. The withdrawals due to changes of tenancy and unwillingness to continue were made up for by the inclusion of new accounting farms. Argyll, South Ayr, Dumfries, Kirkcudbright and Wigtown are, as yet, almost untouched but a tentative start has been made among smaller farms in Dumfries.

Cost accounts.—The Auchincruive cost accounts for 1933-34 were completed after the end of the financial year in March, 1934, and have been continued. Cost accounts on a large dairy farm were inaugurated at the request of the farmer, all analysis and accounting work being done by this Department. Full costs on a poultry farm were commenced at 1st October.

Enterprise costs.—A beginning has been made on this work and a small number of records for milk-production, pigs and crop costs are current. Records were kept at Auchincruive for poultry and pig-feeding costs. Following on the " cost of feeding in milk production " work of previous years, this work has been carried out on various farms at the request of the farmer.

Costs of milk production.—Towards the end of the year a grant was given by the Scottish Milk Marketing Board for the purpose of obtaining information on the costs of milk production. The progress of this work is satisfactory, especially in the south counties. Nearer the industrial areas, however, there has been great difficulty in obtaining farmers willing to co-operate. Additional farms are still being taken on. In order to obtain whatever information is available, records covering full costs, enterprise costs, feeding and depreciation costs and " pure dairy " financial accounts are being handled.

Titles of papers issued during the year.

1. Gilchrist, J. A.: Reports on the financial return of farms in South-West Scotland, 1933-34. Circulated privately.
2. ———: Financial returns from poultry in South-West Scotland. *Scott. Farmer*, February, 1934.
3. ———: Advisory report on poultry farms. Circulated privately.
4. ———: Return from cattle, Winter 1933-34. *Scott. Farmer*, June, 1934.

GRASSLAND

129. ABERYSTWYTH: UNIVERSITY COLLEGE OF WALES (WELSH PLANT BREEDING STATION)

Seeds mixtures.—Investigations relative to seeds mixtures have been continued, and special attention is given to the question of the type of mixture required in connection with the reclaiming of all types of land. A large amount of data has been collected at the various centres. A report on the evidence obtained since this work was started in 1930 is in preparation. This section of the work has attracted the attention of farmers very much, and has led to a good deal of reclamation of hill land on a small scale.

Improvement of rough and derelict grazings.—Investigations on the improvement of rough and derelict grazings both in the lowlands and on hill land are now in progress at eight centres.

Competition in seeds mixtures at high elevations.—An experiment designed to study competition in seeds mixtures under upland conditions has been carried out and the evidence indicates in a general way that competition and persistency as factors in sward formation operate in rather a different way on the uplands as compared with the lowlands.

Pedigree cocksfoot was found to be superior in productivity to pedigree rye-grass, but a small seeding of pedigree perennial rye-grass would appear to be necessary to help protect the pedigree cocksfoot during the first few years.

Montgomery red clover has proved itself to be far better than *Lotus major*, kidney vetch and wild red clover, especially for hay.

Of the bottom grasses crested dogstail and red fescue (pedigree) were superior to rough-stalked meadow grass and smooth-stalked meadow grass. Chewing's fescue got very " winter-burned " and unpalatable. Wild white clover is essential in mixtures for these conditions. It is probable that Italian rye-grass at 10 or even 12 lb. per acre is not too much where the spring grazing is hard and where the fields are not enclosed for hay until early May. Indigenous and pedigree strains have given more hay, more leaf and have been more persistent than the commercial strains.

Title of paper issued during the year.

Thomas, M. T.: Competition in seeds mixtures at high elevations at Moelglomen, Talybont, Cardiganshire. *Ann. Appl. Biol.*, **21**, No. 4, 553-565, November, 1934.

III

OTHER INVESTIGATIONS

PLANT BREEDING AND CULTIVATION

130. PLANT BREEDING WORK ON BROCCOLI

Seale-Hayne Agricultural College

By inter-crossing individual broccoli of apparently perfect type in series of small groups the progeny showed differences in quality and vigour ranging from 10 per cent. to 98 per cent. of the mean quality of the parents. The period of maturity was found to vary similarly between the progenies of different individuals. This has been shown to be due both to the highly heterozygous nature of commercial broccoli plants and to great differences in their capacity to inter-cross successfully.

Methods of diallel crossing have been developed for use both for primary selection work and for further work with inbred pedigree stocks.

In connection with the development of a December to January maturing broccoli which is hardy and satisfactory in quality when grown in West Cornwall, the stock E.U. 37 has proved markedly successful. In 1934 this stock was planted in the Scilly Isles for mass seeding.

Second generation progeny were grown during 1933-4 from Roscoff-Angers crosses and valuable Angers types which are resistant to the leaf-drop fungus (*Mycosphaerella*) have been isolated.

Three pedigree stocks have been passed out to growers during 1934 on account of their success in trials.

131. PRODUCTION OF SEED POTATOES ON A COMMERCIAL SCALE IN NORTH WALES

Bangor : University College of North Wales

By the additional selection of 25 new centres the number of growers participating in the scheme in 1934 was increased to 46, the majority of which were situated in Anglesey and Caernarvonshire.

Although the general tendency in season 1934, was for a slight increase in the incidence of virus diseases, examination of the growing crops showed that, at 30 centres, the stocks contained less than 0·5 per cent. of the plants showing symptoms of infection, and at another ten the amount did not exceed 1 per cent. Of the remaining six, five contained more than 1 per cent. of disease, and at only one centre was more than 3 per cent. recorded. In view of the modified standard of health which was adopted last year by the organisation of growers, all centres with one exception are eligible to sell stocks of certified seed potatoes in the present season.

In replicated yield trials carried out with four varieties at the College Farm and in the Counties, North Wales certified seed potatoes gave results as good in every respect as special stock seed from Scotland.

Approximately 150 tons of certified seed potatoes are available for sale and arrangements for putting this quantity on the market have now been made.

132. FRUIT BREEDING EXPERIMENTS

John Innes Horticultural Institution

The cytological investigations on pears have been continued and expanded. Thirty-four varieties have now been examined, and of these 27 were found to be diploids and 7 triploids.

Pollen germination tests were made in many of these varieties and showed interesting differences when compared with similar tests in apples. As in apples, the triploids had very little good pollen and a low germination percentage. The diploids had good pollen and a much higher pollen germination than the triploids, with the exception of the variety Marguerite Marillat, in which the pollen was very bad.

It was found that the pollen germinated through a much greater range of sugar solutions than was the case with apples. Six concentrations were used, 5 per cent., 10 per cent. etc. up to 30 per cent. Some varieties gave the maximum germination in the 5-10 per cent. culture media, while others gave the best results in the higher concentrations. Thus in Beurre Hardy 82 per cent. of the pollen germinated in 10 per cent. sugar, while the pollen of Beurre Clairgeau burst in this concentration but 81 per cent. germinated in 30 per cent. sugar. It seems possible that these differences in pollen germination of different varieties may to some degree be associated with incompatibility in pears. This part of the work is being further investigated.

Progeny from triploids in apples and pears.—Chromosome counts in seedlings derived from crosses between diploids and triploids were continued. Aneuploids with an irregular number of chromosomes, i.e. not a multiple of the basic number 17, have been discovered among the relatively few seedlings involving triploids as one or both parents that have proved viable. No such aneuploids have been discovered among existing varieties in cultivation, and it will be interesting to see their characters if they come to fruiting.

In apples the majority of seedlings have 2n=41, but several individuals have been found with the diploid number 2n = 34. This may prove to be of importance in view of the fact that Cox's Orange is reported to be a seedling from the triploid Ribston Pippin and that there are varieties in cultivation reputed to be seedlings from Blenheim Orange, the triploid which in our experience has most frequently yielded viable seedlings.

The number of pears examined so far is relatively small, but it was found that where the triploid is used as male parent instead of having the highest frequency at 2n = 41 as in apples, the majority of seedlings have chromosome numbers from 2n = 34 to 2n = 37. Where the triploid is used as female the chromosome number in the seedlings is higher, being about 2n = 41 as in the apples. It will be necessary to make many more counts before the true distribution of chromosome numbers in the triploid progeny of pears is determined; but the preliminary investigation suggests the possibility of breeding from triploids with a reasonable chance of obtaining fertile diploids.

Rubus.—The work on the Veitchberry and tetraploid raspberries has been continued. No new results have been obtained so far, but crosses have been made which on examination should assist considerably in elucidating the problem. The Rubus family is exceptional in the large range of polyploidy which it exhibits, examples having been produced with all numbers of chromosomes from 2 to 8 sets. Among these polyploids the commercial berries of the future are to be expected. The Logan Berry for example is a chance produced hexaploid, whose constitution is being elucidated, with the possibility of arriving at an analogous seedling of finer quality.

133. TRIALS OF HARDY FRUITS FOR COMMERCIAL PURPOSES

Royal Horticultural Society and Ministry of Agriculture

Testing of new varieties of fruit trees.—The year has been marked by unusually heavy crops carried by varieties of all kinds of fruit in the Trials at Wisley and the sub-stations. Twenty-two new varieties of fruit have been accepted for trial. One variety, the plum " Laxton's Bountiful ", was selected, after adequate test at the Central Station, for propagation and distribution to the sub-stations. Additional sub-stations have been established for trials of special fruits, i.e., the station at the Kent Farm Institute, Borden, extended to include trials of apples, pears and plums, in addition to cherries; raspberries and currants will be tested at the Norfolk C.C. Plot at Burlingham; trials of strawberries established at the Botley Experimental Station, Hants.

Canning tests.—The results so far obtained may be summarised as follows:—

> *Raspberries:* The varieties " Lloyd George ", " Pyne's Royal " and " Norfolk Giant " have proved the most satisfactory. Only moderately good results have been obtained with " Red Cross ", although in certain areas this variety is largely grown for canning. " Ellis " has given consistently good results, but is not satisfactory in growth and cropping.
>
> *Black Currants:* The standard varieties " Baldwin ", " Seabrook's Black " and " Boskoop Giant " have all given good results when canned, and of the newer varieties " Davison's Eight " has proved entirely satisfactory.
>
> *Red Currants:* The varieties " Raby Castle " and " Laxton's Perfection " have been tested from other sources, but the two newer varieties, regarded as superior for general commercial planting, have given good results when canned.
>
> *Gooseberries:* " Careless " and " Keepsake " are regarded as the best commercial varieties for canning.
>
> *Strawberries:* Of the seventeen varieties tested for canning qualities several have given satisfactory results, but have proved entirely unsuitable for commercial planting as lacking in healthy vigour and cropping capacity. " Royal Sovereign " and " Sir Joseph Paxton " have given good results. First results with " Brenda Gautrey " (Huxley's Giant), were good, but with later samples the berries have been spoiled by a mould, *Byssochlamys fulva.*
>
> *Plums:* " Victoria ", " Rivers' Early Prolific " and " Purple Pershore " are regarded as good canning varieties. Of the newer plums " Early Laxton " has proved excellent for canning.

Titles of papers issued during the year.

1. Trials of hardy fruits for commercial purposes, 1933. *J. Roy. Hort. Soc.*, **59**, part 1, 1934.
2. Hall, Sir D.: The fruit trials at Wisley.
3. Rawes, A. N.: New varieties of apples and pears.

} Apple and pear varieties and cultivation. Rept. of Conference held by Roy. Hort. Soc., 1934.

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134. STUDIES OF CERTAIN BRITISH PLANTS

Potterne Biological Station

Anagallis.—The work with *Anagallis* is being continued and will probably not be completed for three years. The points being investigated are the inheritance of colour, glands, outline of petal margin, petal shape and leaf shape. Many hundreds of plants have been examined. Further crosses have been made involving new colours; the inheritance of colour is more complex than was at first realised. F_2 families from *A. arvensis* salmon x *foemina* were scored, all possible combinations occurred; it is proposed to carry on selected F_2 plants. Problems arising out of this work have been discussed with a cytologist at Merton, and suggestions have been made for further combinations that may throw light on the colour problem. Cytological investigations of the chromosome numbers of *A. arvensis* and *A. foemina* will be made at Merton this year.

Centaurea.—Fifty F_2 families of hybrid origin made under control containing 2,429 plants were scored. One example of the data obtained is as follows: two collected plants of *C. jungens* Gugl. obtained from experts on the genus *Centaurea* were crossed together, segregation occurred in the F_1. Two F_1 plants were crossed together and in the resulting F_2, plants indistinguishable from *Jacea* and *nemoralis* appeared amongst plants showing a very wide range of combinations, including *jungens*. In 1934 fifty-six selfings and crosses were made with F_1 plants of hybrid origin, *Jacea*, *jungens* and *pratensis* x *nemoralis* and *nigra*. There was more sterility both on crossing and selfing than in previous years.

Epilobium.—In 1934 *E. montanum* was crossed with *E. hirsutum* and an F_1 family obtained which will be scored this year. Further work is contemplated.

Ononis.—The work with *Ononis spinosa* and its variety *mitis* has been rather complicated by great sterility, small generations from both these plants have, however, been obtained, and they are found to be breeding true. This investigation was carried out in connection with the Transplant Experiments.

Ranunculus.—Scoring for sex in a large family of plants from seed obtained apomictically from a female plant of *R. acris* was carried out twice in 1934. Part of the female plant was grown in the Breeding House and further data obtained as to its behaviour.

The investigation of the inheritance of the purple blotch on the leaves of *R. acris* is to begin this year. Purple blotch is already being investigated in *R. Ficaria.*

The work with *R. Ficaria* continues; using the method of Sir Arthur Hill of growing the flowering shoots in water, it has been found possible to cross the tetraploid var. *bulbifera* with the diploid non-bulbil producing plant. This research is slow as three years must elapse from the time the seed is sown before the plants can be scored.

Saxifraga.—New experiments have been initiated with *Saxifraga*, namely crossing *S. tridactylites* and *S. granulata* with *S. hypnoides*. F_1 families have been obtained in both cases. The F_1 from *S. granulata* x *hypnoides* was fertile and an F_2 family has been raised which will be scored this year. The F_1 plants from

S. tridactylites x *hypnoides* flowered very late and were sterile. It is hoped that this year when they flower normally, some may prove to be fertile.

Silene.—Twelve F_2 families were scored containing 665 plants. The research in 1934 fell into three groups: (*a*) to obtain further information of the inheritance of anthocyanin in *S. maritima*, (*b*) to obtain further information of the modification of the testa pattern known as weak armadillo in *S. vulgaris*, other characters were also analysed. Segregation was found to occur for medium indumentum and few hairs, small scale, filament colour, sex, stigmata colour, capsule shape and weak armadillo testa. The remaining group (*c*) to obtain information of the inheritance of inter-specific characters.

Solanum.—The work with *Solanum Dulcamara* and its variety *marinum* is being continued. The selfing of a white var. of *S. Dulcamara* and the crossing of white with type will be scored this year. A wild population of *S. Dulcamara* var. *marinum* was examined at Hurst Castle, Hants, last August, and plants and seed collected.

Transplant experiments.—During the past year periodical recordings have been made. Certain changes were recommended, namely, *Ononis spinosa* and its variety *mitis* to replace *Silene maritima* which has died out. *Plantago major* derived from a small form is again rapidly dying out on all plots but the clay. In 1934 the clay plants were cloned and redistributed, the recording of their behaviour provides interesting data. A new Plantain with very large leaves is now being tested genetically, this will eventually replace the present stock. In the meantime selfed seed from a plant of the old stock grown on the clay will be sown and the plots replanted this Summer. *Plantago* has given some of the most interesting reactions.

Miscellaneous.—One thousand and ten packets of seed have been distributed to botanic gardens and institutions, including The Institute of Animal Pathology at Cambridge. A small pool for growing aquatic plants has been constructed, this had become a necessity as attempts to grow aquatics in small zinc tanks had proved to be unsatisfactory. Despite the dry summer very few plants have died.

Titles of papers issued during the year.

1. Marsden-Jones, E. M., and Turrill, W. B.: Genetics of colour and indumentum of vegetative parts in *Silene vulgaris*. *Roy. Bot. Gdns., Kew: Bull. Misc. Inf., No.* 9, 383, 1934.
2. ———: Further experiments concerning sex in *Ranunculus acris*. *Ibid., No.* 4, 209, 1935.
3. ———: Second selfed families from a wild stock plant of *Silene vulgaris*. Additional studies of anthocyanin inheritance and of other characters in *Silene maritima*. *Ibid, No.* 4 ,216, 1935.
4. ———: Further breeding experiments with *Saxifraga*. *J. Genet.*, **29**, 245, 1934.

5. Marsden-Jones, E. M., and Turrill, W. B.: Third report of the transplant experiments of the British Ecological Society at Potterne, Wilts. *J. Ecol.*, **23**, 443, 1935.

6. Marsden-Jones, E. M.: The genetics of *Anagallis arvensis* Linn. and *Anagallis foemina* Mill. (Read before the Linnean Society, 4 April, 1934.)

In Press.

Marsden-Jones, E. M.: Ranunculus Ficaria: Life History and Pollination.

135. BASIC SLAG EXPERIMENTS

Rothamsted Experimental Station.

The series of four-year hay experiments was completed in 1933 and the results worked up. Early in 1934 it was decided to undertake fresh investigations on medium soluble slags which have recently been produced by some of the works previously making low soluble slags. A technical sub-committee was set up to advise on this work.

A series of eight field trials on four types of slag, mineral phosphate, and no phosphate was laid down in Scotland with the co-operation of Dr. MacArthur and local workers. In order to ascertain whether the basic slags used in these trials were representative, a set of 13 slags was tested in pot cultures at Rothamsted using repeatedly mown perennial rye-grass grown in sand-bentonite mixtures. Nine cuttings were taken in 1934, and it was found that even though single and double dressings of total phosphoric acid were used for each material, the total crop yield and uptake of phosphoric acid were very closely related to the amount of citric-soluble phosphoric acid. Eye estimates of the swede crops in the Scottish experiments also suggested that the responses appeared to follow the citric acid solubilities.

A mineralogical and microchemical examination of the experimental basic slags was commenced, using for the first time the commercially ground samples. The preliminary results revealed clear differences between slags of different origin and citric solubilities. Thus, several medium soluble slags from one works contained calcium tetraphosphate as well as fluorapatite. In other slags the only carriers of phosphorus recognized were two or three silicophosphates.

136. IMPROVED MANAGEMENT OF GRASSLAND

(A) Welsh Plant Breeding Station, Aberystwyth.

These investigations, relative to the nutritive value of grassland plants under different conditions conducted in collaboration with Professor Fagan, have been continued.

During the year under review opportunity has been taken of using the large number of samples drawn from the experiment designed on the basis of live weight increase to compare indigenous cocksfoot with indigenous perennial rye-grass, and to ascertain what results are obtained when wild white clover is included in the mixture and when it is omitted. The samples so far subjected to chemical test have only been those representing the first harvest year of the experiment in question. It is proposed to continue this aspect of the enquiry into the second and third harvest years, and since growth stage has such a considerable influence on the chemical composition of both grasses and clovers it is premature to draw conclusions from data which are not yet complete.

(B) Bristol University.

Certain sections of the grassland investigation programme which has been in progress for several years have now been completed and the Department is now in possession of critical data, the value of which cannot be over-stressed so far as advisory and future investigational work are concerned, upon the following aspects of grassland :—

(i) The effect of different systems of manuring and management on the nutritive value of grass and hay ;

(ii) the influence of local conditions of soil and climate in the West Country on the nutritive value of herbage ;

(iii) the monthly nutritive value of the herbage of water meadows, cow-pastures and Wiltshire Down land under conditions of both good and bad management ;

(iv) the " mineral " content of West Country pastures ;

(v) the iodine content of certain pastures ;

(vi) the effect of folded poultry on the chemical composition of relatively poor pastures ;

(vii) the losses that occur in the making of grass silage in the stack, with and without the use of molasses, A.I.V. solution and ordinary water ; and

(viii) a comparison of the yields and nutritive value of fodder obtained by the practices of grazing, hay making and silage making.

A paper read at the Third Grassland Conference of the North and Central European Countries held at Zurich in July, 1934, dealt with the seasonal variation in the composition of some typical pastures in the South-West of England.

137. BREEDING OF OATS RESISTANT TO FRIT-FLY

School of Rural Economy, Oxford University.

The analysis of variance proved that resistance is inherited ; the new strains show that resistance and quality can be combined. The work of multiplying stocks of the better strains for independent trial was commenced this season. A new technique, namely, mass culture of the progeny of hybrids, was added in order to extend the range of selection. Certain " land " varieties and strains from Finland were examined, a search for better parent forms always being part of the programme of work.

New hybrids were produced and further selections were made from new strains, derived from hybridisations of various parent types and ranging from those in their second to those in their seventh year.

Differences between extent of infestation of susceptible and resistant types were shown to be inconstant throughout the possible range of attack and an indication that extent of infestation itself showed some degree of correlation with rainfall was obtained.

PLANT DISEASES AND PESTS

138. BACTERIAL DISEASES OF PLANTS

Imperial College of Science and Technology.

Experiments on hypertrophy of sweet-peas.—In last year's report it was stated that mixed bacterial cultures isolated from diseased plants were capable of reproducing the disease when inoculated into young seedlings. Considerable further work has been done on this disease, but the causal agent has not yet been identified. Positive infections are regularly obtained by growing seedlings in infected soil in which hypertrophied plants have previously developed; in soil in which water containing macerated hypertrophied tissue has been added, and in soil watered with suspensions of mixed bacterial cultures developed on isolation plates from hypertrophied tissue. Inoculations of soil with single colonies of bacteria from isolation plates, however, have invariably given negative results. Filtrates from suspensions of crushed hypertrophied tissue from infected soil and from isolation plates of bacteria also gave negative results. No infection was obtained from control plants grown in sterilised soil, in ordinary untreated soil or in sterilised soil watered with suspensions of bacteria grown from the second. The seedlings must be infected at a very early stage; attempts to infect plants after they have reached a height of 4-5 inches failed, although the disease does not usually become apparent in infected seedlings until they have reached this age or even later. Further culture work and other inoculations are in progress.

Work on the green-fluorescent bacteria of the Pseudomonas group.—Two more parasitic species of this group have been isolated *Bact. vignae var. leguminophila* from *Phaseolus vulgaris* seeds, and a strain from a rot of lily; inoculation of these on plants susceptible to various members of the group have been carried out. Further work has been done on the question of virulence; the strain, 234, which quickly loses virulence on nutrient media has been tested on media of a wide range of pH values and in various potato extracts, filtrates from cultures and from rotted tissues, etc., and further comparisons have been made between virulent and avirulent strains.

Marsh-spot of peas.—In last year's report it was stated that experiments were being carried out to try to induce the disease by such means as excessive watering, alternations of moist and dry conditions, etc. All these experiments gave negative results; no marsh-spot at all developed in any of the experimental plants.

139. METHODS OF CONTROL OF THE RASPBERRY AND LOGANBERRY BEETLE AND THE USE OF TUBA ROOT (*DERRIS ELIPTICA*) AS AN INSECTICIDE

EAST MALLING HORTICULTURAL RESEARCH STATION.

Raspberry beetle.—Research on raspberry beetle control has been continued along the lines which past seasons' experience has indicated. Field spraying and dusting trials were carried out on raspberries, loganberries and blackberries, and their results will be published shortly.

A trial of derris dusts on raspberries showed that even a heavy application of a dust containing 0·36 per cent. (crude) rotenone, applied to kill the adult beetles, is inferior to a wet spray of derris and soap (crude rotenone content ·007 per cent.) applied to kill the larvae. The efficiencies of these two methods were of the order of 44 per cent. and 93 per cent. respectively.

Small scale trials confirmed last season's finding that a single spraying of derris and soap gives an adequate commercial control of the pest on cultivated blackberries (1).

A spraying trial was carried out on loganberries. The results foreshadow the possibility of controlling beetle and cane spot (*Elsinöe veneta*) at one and the same time by means of a combined insecticide and fungicide. Thus a mixture containing lime sulphur and derris gave a good control of beetle and a measurable degree of control of cane spot. Problems of spray deposit naturally arise when such a spray mixture is applied at the optimum time for beetle control (late June). The deposit may be visible and so detract from the market value of the fruit, or it may be inconspicuous but yet objectionable from the point of view of the canning industry. The help of a local firm of canners was, therefore, enlisted to investigate the effect on cans of the small quantities of sulphur and copper which persisted on sprayed berries.

Future work on this pest will probably be limited to trials of dual purpose sprays for combined cane spot and beetle control.

Derris root as an insecticide.—Research under this heading has comprised both laboratory tests and field spraying trials.

(*a*) *Laboratory tests.*—These have been carried out in collaboration with Rothamsted Experimental Station. Many difficulties of technique have now been overcome and suitable methods for carrying out the laboratory tests particularly with larvae of the Vapourer Moth (*Orgyia antiqua*) have been devised. It is hoped that it will eventually prove possible to correlate toxicity to various types of insect with the chemical and physical properties of the root.

(*b*) *Field spraying trials.*—Derris root was again used (in both wet and dry form) against a variety of fruit tree pests. Used largely as an ingredient of standard spray mixtures, it was tested in comparison with other well known and some new insecticides.

Titles of papers issued during the year.

1. Steer, W.: Studies on *Byturus tomentosus* Fabr., IV.—1933 Experiments on the control of the raspberry and loganberry beetle. *E. Malling Res. Sta. Ann. Rep.* 1933, 217-219, 1934.
2. ———: Studies on *Byturus tomentosus* Fabr. V.—1934 Experiments on the control of the raspberry and loganberry beetle. *Ibid.*, 1934, 191-193, 1935.
3. Steer, W., and Thomas, F. J. D.: Field spraying and dusting trials on the control of apple blossom weevil and of apple sawfly in 1934. *Ibid.*, 1934, 194-204, 1935.
4. Thomas, F. J. D.: Preliminary experiments on the control of apple surface eating tortricid larvae. *Ibid.*, 1934, 205-207, 1935.

140. STRAWBERRY DISEASE FIELD INVESTIGATIONS

READING UNIVERSITY

Hot water treatment of runners (1, 2).—Results may be summarised as follows:—

(i) Hot water treated plants are completely freed from strawberry mite, red spider and aphis.

(ii) The plants, once over the initial check, which is apparently unavoidable, show greater vigour than untreated ones. They produce more numerous and more vigorous runners in their maiden year.

(iii) Provided that plantings are made in sufficiently large blocks reinvasion of the plants by the pests specified above is slow.

Aspects of this problem still under investigation include (*a*) a determination of the optimum season for treatment, with a view to reducing the initial check to a minimum, and (*b*) the effect of the treatment upon strawberry eelworm, and the value of the addition of chemicals to the bath for fungicidal and other purposes.

Strawberry weevil (*Anthonomus rubi*).—Arsenic dusts again gave a good control, but the treated fruit was again found to contain up to 2·15 parts per million of arsenic. Experiments have also been made with non-poisonous derris dusts, which gave up to 70 per cent. control.

Strawberry aphis (*Capitophorus fragariae*).—An attempt was made to keep the plants free from this pest throughout the spring and summer, by repeated spraying and dusting. The attempt was successful, but no apparent advantage resulted to the plants. Useful data on the technique and costs of spraying were, however, collected.

Tar-distillate spraying.—The value of the practice of spraying strawberry plants with a tar-oil wash in the late summer, to destroy old foliage and the pests thereon, has been tested by a comparative trial. The results indicate that no benefit is derived from the practice, and that growth is checked by it.

Other investigations.—A start has been made on a critical examination of the inter-relations of strawberry eelworm, red plant, and cauliflower disease. At this stage no statement can be made, but valuable data are being accumulated, and it may well prove that contrary to our previous impression eelworm plays a considerable part in the general unthriftiness of the strawberry.

Titles of papers issued during the year.

1. Hodson, W. E. H.: Pests in strawberry plantations: their elimination by the hot water system. *Fruitgrower*, **76**, Sept., 1933.
2. ————: Hot water treatment for strawberry mite. *Estate Mag.*, **33**, 12, 926-928, 1933.
3. ————: The control of strawberry pests by hot water treatment of runners. *J. Min. Agric.*, **40**, 12, 1153-1161, 1934.

141. WART DISEASE OF POTATOES

ROTHAMSTED EXPERIMENTAL STATION

A hundred and ten specimens belonging to forty-six numbered and eight named varieties were received between 24th January and 12th April, 1934. They were examined on arrival both macro- and micro-scopically and an initial report on them sent to Ormskirk. Fresh warts for reinfection were attached to the shoots and the specimens kept in an infection chamber and examined periodically until 10th July when those which had survived were discarded.

Although only two of these varieties were found to be susceptible, 32 others showed a certain amount of infection (production of sporangia and occasionally slight necrosis) which subsequently disappeared. Only 10 varieties showed no infection at any stage.

142. BIOCHEMICAL INVESTIGATIONS ON THE ROOT EELWORM DISEASE OF POTATOES

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE (INSTITUTE OF AGRICULTURAL PARASITOLOGY).

Experiments have been carried out on the isolation of the constituent of root excretions of potatoes and other plants (e.g. rough and smooth stalked meadow grasses) which is the stimulant factor concerned in the liberation of the larvae of *Heterodera schachtii* from the cysts in infected soil. The sand or soil in which potatoes are growing, is saturated with distilled water two or three times a week, and the solution draining through is collected. This is evaporated under diminished pressure at 24°C. to about 100 ml. This is centrifuged to remove insoluble material and treated with successively higher concentrations of alcohol. Various precipitates are formed and collected, the most active fraction being soluble (in the presence of this volume of water) in 75 per cent. alcohol. This fraction, although containing over 50 per cent. of ash in the sand experiments and over 80 per cent. in the soil experiments is active in a dilution of one part in 500,000 of water. All the fractions contain active material and it was suspected that this was due to its being surface-active. This was demonstrated by the fact that the most active fraction " spreads " on water, and when its solution is shaken with vegetable carbon (Norite), the filtrate from this is inactive. Some of the more active fractions gave a positive " Ninhydrin " reaction for amino-acids and experiments were carried out with the commoner amino-acids to determine whether solutions of these would liberate the larvae from cysts. Alanine, aspartic acid, asparagine, glutamic acid, glycine, leucine and tyrosine were tried in several experiments. In all cases tyrosine gave positive results and in most cases, to a smaller extent, alanine and glutamic acid. In no case did the activity approach that of root excretion. Further purification of the active fractions is proceeding.

Delayed hatching of larvae.—It was noticed that the root excretion from potatoes (themselves in very poor condition) growing in sand in a particular box, possessed no activity. In view of the fact that the presence of the merest trace of active excretion would have been demonstrated, some other factor was looked for, and the box was found to contain a great deal of rusty ironwork in its construction. Experiments were, therefore, carried out on the hatching of larvae by root excretion in the presence of iron rust. It was found that the rate of hatching was retarded considerably for the first week or ten days, but not after that period. Similarly, ferrous sulphate solution, which deposited a copious precipitate on standing, delayed hatching for about the same period. These results are important in view of recent work by Carrol & McMahon, who have shown that, in pot experiments with potatoes growing in infected soil, if hatching is delayed until a fairly strong root system is developed, the plant can withstand the infection.

Control of Eelworm.—A solution of N/2 $Fe_2 Cl_6$ was found to kill eelworms in a few hours. Greater dilutions were tried and it was found that N/10 solution killed most of the worms in one day, and all of them in four days. N/50 solution killed the majority, but not all, in four days. N/1,000 killed more than 50 per cent. in four days (this result to be confirmed).

Cysts were placed in N/2 $Fe_2 Cl_6$ solution (+ root excretion) for one week. No hatching occurred. The cysts were then placed in successive portions of distilled water for two days, to remove the $Fe_2 Cl_6$. Root excretion was then added, but no hatching took place. The effect of weaker solutions of $Fe_2 Cl_6$ on the cysts themselves, has not yet been tried.

$FeSO_4$ in solution of strength N/50 or less, appeared to have little or no lethal action on eelworms. A N/10 solution killed over 50 per cent. of the worms in four days.

A preparation of hexylresorcinol was found, in sufficient concentration, to paralyse eelworms in less than one minute. Practical application of the use of this substance may, however, be prohibited by its cost.

It has been stated that practically no *H. schachtii* larvae can be induced to hatch in the winter, even when experiments are carried out at a suitable temperature in an incubator. If, however, cysts have previously been soaked in water for several weeks, on replacing the water by root excretion, hatching, at room temperature, proceeds as rapidly in winter as at any other season. Further, irrespective of seasonal restrictions, an experiment can be carried out with soaked cysts in a week which would, with unsoaked cysts, take three or four weeks.

143. ECOLOGY OF APHIDES INFESTING THE POTATO CROP

Bangor: University College of North Wales.

When over a thousand winged migrating *Myzus persicae* were collected at a centre known for the rapidity in which the potato stocks degenerate through spread of virus diseases, it was found, by feeding on healthy plants that a very small percentage, probably not more than 0·4 per cent., were infected with leaf roll. This small percentage suffices to introduce infection into healthy stocks, and subsequent spread is by wingless aphides.

The population of winged *Myzus persicae* at a centre, Holywell, where spread of virus disease is rapid was very considerably greater than at Aberdaron where the spread is negligible. These winged forms reproduce wingless forms rapidly and result in the heavy infestation of wingless forms in the former district.

Laboratory experiments show clearly the retarding effect of high humidity upon the flight of winged *Myzus persicae*; flight practically ceases when the humidity exceeds 75 per cent. relative humidity. The humidity in the Holywell district is much lower than at Aberdaron. The greater intensity of the migration of aphides during easterly winds is attributed to the drier conditions prevailing.

There was no evidence of migration across the Dee Estuary from the market-gardening districts of Lancashire, but these results need to be confirmed by trapping at higher altitudes.

Observations showed that drought conditions caused cruciferous weeds to wilt and die with the result that winged aphides were produced on these plants in considerable numbers.

Experiments showed that it is impracticable to spray a small area of potatoes within the general crop as a means of controlling the aphis infestation and spread of virus disease since such sprayed areas rapidly become infested by migrating wingless aphides from adjoining plants.

144. MARSH SPOT IN PEA SEEDS

South-Eastern Agricultural College, Wye.

Some 273 samples of green peas, which had been grown in fields throughout the county and in trials on the College farm during the summer of 1933, were examined, together with seventy-five samples of the stock seed and the incidence of marsh spot was ascertained. A distinct general correlation was found to exist between the occurrence of marsh spot and the type of soil upon which the peas were grown. The effect of the disease on the germination of the peas was also investigated.

In the spring of 1934 two firms of seedsmen supplied particulars of the fields of peas to be grown under contract for them in Romney Marsh and in East Kent generally.

A survey of the soils in about eighty of these fields was carried out. Plots were also laid out in five fields to test the effect of potash manuring on the incidence of marsh spot.

Stock seed used for each contract crop was obtained and part was examined for marsh spot and part was sown on Pond Field on the College farm. In this way about 80 contract crops were represented, in rows, on the same field. The effect of potash manuring was also investigated on these rows.

At harvest, samples of pods were collected from each area of different soil in each field and from the plots in Romney Marsh and on Pond Field. In all about 471 samples were gathered, dried and threshed. Their examination, together with that of seventy-four samples of the stock seed, has been carried out.

DAIRYING AND ANIMAL HUSBANDRY

145. "BLUEING" OF CHEESE

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING.

This investigation was begun in the spring of 1934, and is as yet in its very early stages.

Consumers have complained in recent years that it is becoming increasingly difficult to obtain cheese of the true Stilton type. Blue cheeses of the traditional shape and size are of course on the market but these appear to lack some of the characters which distinguish the Stilton cheese of the connoisseur. Some of the powerful reasons for the partial abandonment of the manufacture of true Stilton cheese have been (i) the uncertainty of blueing, (ii) the long ripening period, (iii) the loss in weight during ripening, and (iv) the severe losses from faults of various kinds including putrefaction.

The objects of this investigation are (*a*) to establish reproducible conditions for controlling the process of "blueing", (*b*) to determine the chemical and micro-biological characteristics of a true Stilton. An incidental objective is to cut down the time required for the ripening process, though it is realised that this may result in the production of a cheese not strictly Stilton in type, but nevertheless acceptable to the consumer and possibly capable of replacing similar but cheaper imported types.

The rate of development of the "blue" mould of Stilton cheese, and incidentally, the possibility of hastening the ripening process appear to be closely correlated with the oxygen tension in the interior of the cheese.

Pricking will usually ensure "blueing", but we have evidence that the stage at which it is practised is of importance. Too early pricking may result in precocious "blueing" and immature cheese. Inoculation of the curd with mould spores will ensure their presence in the cheese but preliminary experiments have indicated that the lighter inoculation of the "natural" infection resulted in slower "blueing" but fuller flavour. These points and also the effect of ripening the cheese in atmospheres rich or deficient in oxygen are being studied in greater detail.

The course of ripening of a cheese may be followed to a limited extent by means of boring, but this eventually involves damage and cannot be practised indefinitely. Information is therefore being sought from a series of analyses of internal and evolved gases, and from x-ray photographs.

Chemical analysis has indicated that a comparison of the quality of individual cheese may be made by estimations of volatile acids, and Sorensen and ammonia nitrogen.

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146. BACTERIAL FLORA IN COWS' MILK

GLASGOW: WEST OF SCOTLAND AGRICULTURAL COLLEGE.

As noted in the Report for the previous year, the comparatively high incidence of *Aerobacter* types of coliform bacteria in unpasteurised milk renders it of importance to determine the source of these organisms, especially in view of the fact that such types are widely accepted to be chiefly of non-faecal origin. Recent work has shown that *Aerobacter* types are commonly found in human faeces, but under normal conditions in very small numbers. Consequently it was thought advisable to determine whether the same obtained for bovine faeces. The examination of specimens of bovine faeces, commenced the previous year, was therefore continued, employing firstly direct plating methods for the isolation of coliform types (*Escherichia* and *Aerobacter*) and secondly special methods suitable for the enrichment of *Aerobacter* types.

One hundred and fourteen specimens were examined. It was found that the majority of coliform strains isolated by stroking on plates of MacConkey's bile-salt agar (either directly from the faeces or from a preliminary enrichment in MacConkey's bouillon) belonged to the *Escherichia* types, especially *E. communior* and *E. coli*, while only a few strains were of the *Aerobacter* types. Even where special methods suitable for the enrichment of *Aerobacter* types were used, these organisms were seldom obtained.

It was, however, thought advisable to continue the examination of bovine faeces for *Aerobacter* types using larger quantities of the material and employing various enrichment methods. An additional fifty specimens were examined in this way, and *Aerobacter* strains were obtained from forty-five of them. From these specimens one hundred and sixteen strains of *Aerobacter* were isolated, the types most frequently found being MacConkey's Nos. 108 (*A. cloacae*), 103 (*A. aerogenes*), 98, 73, 67 and 65.

These results show that (i) the coliform flora of faeces of bovine origin corresponds very closely with the coliform flora of faeces of human origin, and (ii) the presence of *Aerobacter* types in milk and on dairy appliances, is probably due in the first instance to faecal contamination and not as is commonly believed to non-faecal contamination.

Titles of papers issued during the year.

1. Malcolm, J. F.: The occurrence of coliform bacteria in milk. *J. Dairy Res.*, **5**, 15-28, December, 1933.
2. ———: Coliform bacteria in milk. *Scott. J. Agric.*, **17**, 189-197, April, 1934.

147. CONTROL OF FLIES IN COWSHEDS

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING.

Flies are of commercial importance to the dairy farmer from at least two points of view. At almost any time they are a source of contamination of milk or utensils and under some circumstances this may lead to a lowering of the quality of milk and even to financial loss. Beside this, in hot weather, annoyance of his cows by flies may decrease their output of milk.

Information on the problem of fly infestations has, therefore, been collected with regard to (*a*) some of the factors affecting the cowshed population and (*b*) the use of fly sprays as a means of preventing annoyance in the field.

Most of the work was carried out during August and September and, although there were long periods of warm sunny weather, the cowshed temperature rarely exceeded 80° F. and there were no hot periods of sufficient duration to be described as ideal for heavy fly infestations. In addition, the efficient methods of disposal of farm yard manure and the general cleanliness of the Institute's farm buildings discouraged large fly populations. Consequently it is not surprising that during the investigations the work was somewhat hampered by lack of flies. There is no reason to think that flies were sufficient in number or activity to be of much consequence with regard to the cleanliness of the milk produced, and the amount of annoyance in the fields during this period was not marked.

(a) *Investigation of certain factors affecting the cowshed fly population.*

Temperature.—In August and September it was found that there was no clear-cut correlation between the cowshed temperature and the concentration of flies. It appeared that an isolated hot day or two had no marked effect on the cowshed fly population but on one occasion a period of five hot days led to a very big increase.

Colouring of Windows.—Painting the cowshed windows with blue distemper had no appreciable effect on fly concentration.

Spraying cows with fly repellents.—Two fly spray repellents had a marked effect on the number of flies associated with the cows on entering the milking shed. There was some evidence of the repellent effect of the spray five days after stopping spraying.

Brushing flies off cows on entering cowshed.—A brush made from dried reeds has been devised for sweeping flies from the cow's back and sides on entering the cowshed.

(b) *Annoyance of cows by flies.*—Using eight control and eight experimental cows it was not found possible to demonstrate a rise in milk yield due to daily spraying with proprietary fly repellents. The experimental period was during the first fortnight of September, during which time there was not a very large or active fly population.

148. SHEEP FEEDING TRIALS

SCHOOL OF RURAL ECONOMY, OXFORD UNIVERSITY.

One object of these trials was to determine the effect of successive increments of net energy in the live-weight increases of fattening tegs. From calculations of the actual live-weight increases recorded, the predicted live-weight increases based on T. B. Wood's figures and on the figures suggested by Watson, Ellis and Skilbeck in their previous reports, it appeared that Wood's maintenance figures were unsatisfactory. The predicted live-weight increases based on the previous Oxford experiments accorded fairly closely with the actual live-weight increases for those pens on the higher nutritional rate but were much below the actual increases for the pens on the lower nutritional rate. The live-weight increases were found to be proportional approximately to the total energy intake. It seems probable that the generally accepted assumption, namely, that the live-weight increase is simply proportional to the energy intake less the maintenance requirement, is not even approximately true.

An extension of this investigation, in which older sheep were used, was made to throw light on the maintenance requirements of sheep on a substantially lower energy intake than that of the previous trials. Again it was shown that the maintenance requirement is considerably below Wood's standard; in fact the pen on the lowest ration, which gave a weekly live-weight increase of 0·66 lb. should, according to Wood, have declined in weight. It was again demonstrated that, assuming Kellner's figure for maintenance, the energy required for live-weight increase was much less for those pens on the lower nutritional rate than for those on the higher rate.

V

ANIMAL DISEASES AND PESTS

149. BOVINE TUBERCULOSIS

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING.

The experiments during the spring and summer of 1933 on feeding guinea pigs and calves on grass infected with an emulsion of bovine tubercle bacilli were concluded. The grass had been infected four times at roughly monthly intervals. In every case of animal infection the bovine tubercle bacillus had been not only demonstrated in the lesions microscopically, but also cultured.

(*a*) Animals allowed to graze on the pasture: Of ten guinea pigs eight proved tubercular. Of three calves all proved tubercular.

(*b*) Animals kept in sheds and fed daily on a ration of infected grass: Of twelve guinea pigs, six proved to be tubercular. Of three calves, two proved to be tubercular.

An experiment was begun in April, 1934, to endeavour to infect calves with bovine tuberculosis by allowing them to graze on pasture that had been infected in the spring by the dung of calves that were being fed daily on an emulsion of virulent bovine tubercle bacilli. The dung from each of the three calves used was proved to contain virulent bovine tubercle bacilli from the day the calves were turned loose in the pasture to the day they were removed for slaughter.

The pasture having been eaten bare, the infected dung was raked evenly over the whole area after the animals had been removed. The grass was allowed to grow and the area divided into four plots. At the end of five weeks an excellent growth of grass had appeared and a couple of calves that had passed the tuberculin test were placed on No. 1 plot and allowed to graze it bare. A month later another pair were placed on No. 2 plot and again a month later a third pair were placed on No. 3 plot.

It is hoped in the event of any of the calves proving to be tubercular, that an indication may also be given as to whether the age of the pasture has any influence on the infection of the calves.

150. SHEEP MAGGOT FLY INVESTIGATIONS

(A) LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE.

Effects of temperature and humidity.—Experiments on the effect of temperature and humidity on survival and development of all stages of *Lucilia sericata* except the larva were carried out. It was found that the most important factor for the egg, prepupa, and pupa was humidity : in adults age, sex, and amount of carbohydrate reserve are most important in determining length of life.

Relative resistance of competing species.—The order of resistance to high temperature and low humidity at all stages, for four important species of carrion flies, was found to be (i) *Phormia caerulea*, (ii) *Lucilia sericata* and *Sarcophaga falculata*, (iii) *Calliphora erythrocephala*. This is the reverse order of their appearance in spring and summer.

General physiological data.—Changes in wet-weight and percentage dry weight, and histological changes in the fat body, were followed in adult flies from emergence to death.

Food requirements of sheep maggots.—An investigation was made of the growth of *Lucilia* larvae on a fat-free diet. The growth-promoting effects of different fats varied widely, the results suggesting that these larvae require a fat-soluble vitamin. It is of interest to note that wool grease proved the richest source with unsterilised larvae. Bacterial synthesis may occur under certain conditions, and further experiments are therefore necessary with aseptic larvae. Progress was also made in the investigation of the growth of unsterile larvae on blood and serum, of which a preliminary account was given in last year's report.

Title of paper issued during the year.

1. Evans, A. C.: Studies of the influence of environment on the sheep blowfly. *Lucilia sericata* Meig. 1. Influence of humidity and temperature on the egg. *Parasitology*, **26**, 366-377, 1934.

(B) UNIVERSITY COLLEGE OF NORTH WALES, BANGOR.

Relationship of humidity to blowfly attack.—It was observed in the dry summers of 1933 and 1934 that sheep-maggot attacks were much fewer than usual : many sheep bore eggs or larvae which had dried up. An investigation of the relation of humidity to development of larvae, coupled with a study of humidity conditions in the fleece, was made. It was found that in general the air in the fleece was too dry for the survival of maggots, except around the rump, and occasionally across the shoulders also. This agrees with field observations of " striking " of sheep. Once the fleece is thoroughly wet e.g. after dipping, or very heavy rain, it will remain sufficiently moist long enough for maggots to establish themselves on any part of the animal. To avoid this, it is recommended that lambs should be shorn with the ewes, in early summer.

Substances inducing oviposition of Lucilia.—The presence of certain substances among the wool of living sheep has been shown to induce oviposition on the treated area. The substances include excreta of *Lucilia* larvae, faeces of scouring sheep, and various products of bacterial decomposition in alkaline conditions. Oviposition only occurs on live sheep so treated i.e. the sheep provides an essential complementary stimulus. This observation is important as explaining the rapid increase of infestation on sheep once struck (since larval excreta are a powerful attractant).

(C) NATURAL HISTORY DEPARTMENT, UNIVERSITY OF ABERDEEN.

Breeding experiments.—Four pairs of *Lucilia sericata* were placed in an observation cage. Among them they laid 6,734 fertile eggs, an average of 1,683 per female, in 36 batches over a period of 22 days. The larvae continued to feed for a period of 7-9 days at room temperature (2-3 days at 32° C.).

Prepupal stage.—Fully fed larvae go through a prepupal stage in which they wander about for a time, and later become dormant. At room temperature the dormant stage was prolonged indefinitely and pupation delayed. In incubator conditions (27°-32° C.), a large number of larvae pupated after a few days dormancy : the remainder would pupate over a month or more.

Larvae which had been dormant at room temperature pupated very quickly on a rise in temperature : this is evidently the normal process, as *L. sericata* is known to over-winter in the larval stage.

Pupation.--The duration of pupation was found to be fairly constant at constant temperature. At room temperature it was 21 days : at 27° C., 6-7 days ; at 32° C., 5 days.

It was found that a considerable proportion of larvae deprived of food after 5 days, and a smaller number deprived of food after 4 days, were capable of pupation, and produced viable flies. This point is important, as shepherds after cleaning " struck " sheep usually drop the maggots without killing them, and many of these may give rise to flies.

Trapping experiments.—A number of fly traps were put out in various situations and the catch collected and recorded every few days from May to October. The flies caught included many *L. sericata* and *L. caesar*. The numbers of the two species were more or less proportional ; most were caught in the traps on open fields. There seemed to be no correlation between number of flies caught and weather conditions, but there was a fair correlation between numbers of flies and incidence of "strike " in the neighbourhood.

151. CONTAGIOUS BOVINE ABORTION

HANNAH DAIRY RESEARCH INSTITUTE.

Progress has been made in the experimental segregation scheme which is being carried out in collaboration with the Scottish Committee on Contagious Bovine Abortion. At present this scheme covers twenty herds, the incidence of infection in these herds varying from 8 per cent. to 42 per cent. Most of the herds have been tested four times, but four herds recently included in the scheme have only been tested once. It is impossible to say at this stage in the investigation how far the method is meeting with success, but it can be definitely stated that, where suitable precautions are taken, there are indications that the spread of the disease can be effectively checked.

152. WORM INFESTATION OF SHEEP INVESTIGATION

Rowett Research Institute, Aberdeen.

Survey.—The survey of the different species of worms affecting Scottish sheep is almost complete. The counties of Berwick, Roxburgh, Selkirk, Argyll, and Inverness were visited in August, 1934, and a total of 16 farms inspected, and 8 sheep autopsied. The material obtained is now being examined in detail and the worms identified and counted.

The influence of minerals on the susceptibility of sheep to parasitic worms.—Twenty Blackface ewes and 47 Blackface lambs of known nutritional history from Garrochoran, Argyllshire, were slaughtered on the 17th September, and the fourth stomachs and intestines retained for a count of the worms present. The total number of worms found in the fourth stomach, small and large intestines of the ewes is being counted but in the case of the lambs only the stomach worms are being reckoned with. After a complete picture of the worm burden of the different hefts has been obtained it should be possible to say whether the feeding of minerals has any beneficial effect in reducing the degree of worm infestation in hill sheep.

Titles of papers issued during the year.

1. Orr, J. B., Fraser, A. H. H., and Robertson, D.: Parasitic worms and their importance in sheep farming. *Trans. Highl. and Agric. Soc. Scot.*, **46**, 113-125, 1934.
2. ———: The problem of parasitic roundworms in sheep. *Trans. Yorks. Agric. Soc.*, **91**, 35-38, 1934.
3. Orr, J. B.: The association of nutrition and helminth infestations. Paper read to Sections I and M, British Association for the Advancement of Science, Aberdeen, 1934.

153. FOWL PARALYSIS INVESTIGATION

Molteno Institute for Research in Parasitology, Cambridge University.

Occurrence of fowl paralysis.—In 1,169 fowls examined in routine post-mortem examinations, 56 (i.e., less than 5 per cent.) were found affected with genuine neurolymphomatosis. Paralytic symptoms without the lesions characteristic of fowl paralysis were observed in a much larger number of birds: these included birds suffering from coccidiosis, tapeworms, and vitamin D deficiency.

Ovarian tumours of the lymphoma type were noted in birds from flocks in which fowl paralysis existed. The conclusion is reached that lymphomatous tumours are probably manifestation of the same disease.

Anatomy of neurolymphomatosis.—Neurolymphomatosis can be stated to be a peculiar localisation of lymphoidal cells in the peripheral nerve which have been previously altered in some specific manner; these same proliferating lymphoidal cells may settle also in the other organs if these are in any way damaged. This explanation agrees with observed facts, namely (i) the difficulty if not impossibility of transmitting the neural lesions, (ii) the presence of tumours, (iii) the apparently hereditary features of the ailment, (iv) its frequent correlation with parasitic infestation.

It has been found possible to transmit lymphoma in fowls with regularity and to obtain lymphoidal infiltration of liver and kidney, a much enlarged spleen and lymphoidal type of bone marrow by inoculating fowls with minced spleen and liver from fowls with tumours of this type. The incubation is extremely variable, between 9 days and 5 months. Infiltration of the nerve does not occur.

Coccidiosis and fowl paralysis.—As a result of histological examination the conclusion is reached that focal infiltrations of the nerve occur where coccidiosis is present and that these infiltrations are similar to those found in genuine fowl paralysis which however are diffuse: the difference is therefore one of degree.

Eye lesions of fowls.—Cases of irido-cyclitis in fowls have been observed and were considered to be independent of fowl paralysis although it is admitted that in fowl paralysis infiltration of the iris may occur.

It is concluded that blindness is not always a sign of fowl paralysis.

Feeding experiments.—Forcible feeding of affected birds with greenstuff has been carried out on 18 birds. In five recovery was obtained, that is, the birds were able to walk. These birds were then killed and their nerves examined histologically.

Attempts to transmit by inoculation.—Out of 337 fowls killed after inoculation with ground up tissues of birds affected with fowl paralysis, only five have developed neural lesions.

154. FOUL BROOD DISEASE OF BEES INVESTIGATION

ROTHAMSTED EXPERIMENTAL STATION.

Sixty samples of diseased brood received have been classified as follows:—

> American foul brood 26, European foul brood 8, uncertain 17, sac brood 2, chalk brood 2, chalk brood and drone laying queen 1, and drone laying queen and decomposing brood 4.

It is at present unknown whether the brood in the samples recorded above as uncertain died as a result of chilling or neglect or from some hitherto undescribed cause. The occurrence of *Bacillus larvae* in apparently pure culture in samples of American foul brood has been confirmed. The fact that European foul brood normally occurs only in the early part of the brood-rearing season has also been confirmed. In this disease *Streptococcus apis* and *Bacillus alvei* have been found to occur alone and together in infected and in dead brood.

So far it has been found impossible to infect the brood in experimental nuclei with either *S. apis* or *B. alvei*, or with a combination of both these organisms. However, both these bacteria when fed to young larvae which are subsequently starved multiply in the host and bring about a decomposition not unlike that found in actual cases of this type of disease. This appeared to constitute a method of infecting brood in experimental nuclei, advantage being taken of the possible enhancement of virulence of these organisms during passage through the host. So far all attempts to create infection in this manner have proved futile. Failure to initiate infection may be due to some seasonal factor or perhaps to loss of virulence by the bacteria. It is possible that a combination of some filtrable virus with the bacteria is required in order to cause infection.

FOOD PRODUCTS

155. BLACKENING OF POTATOES

Imperial College of Science and Technology.

It has been shown that there are two oxidising systems associated with blackening of the potato, one of them thermolabile and the other thermostable. The thermolabile one produces rapid blackening when the tissues are killed by some agent such as chloroform which is not destructive of enzymes. The second system must be responsible for blackening after boiling, for such treatment destroys enzymes. The thermostable blackening system apparently has a high temperature coefficient; for thin slices of potato heated for one minute only, although killed, show no blackening. Prolongation of the high temperature after killing appears to be necessary for the appearance of darkening.

Considerable time has been spent on the development of an empirical colour test which might be used on slices of potatoes on the farm. The application of tyrosin was found to differentiate in 10 minutes the non-blackening and blackening types of Majestic potatoes, but it is not altogether satisfactory with other varieties. A test with tuber slices in which ordinary alcohol is used is now being investigated; it has been successful in distinguishing non-blackening, slightly blackening and blackening tubers in nine varieties to which it has been applied. It is thus very promising and simple in use. The question of the relationships of blackening to the cultural conditions of crops has not yet been studied.

156. FUNGUS (*BYSSOCHLAMYS FULVA*) INVESTIGATION

Imperial College of Science and Technology in conjunction with the Fruit and Vegetable Preservation Research Station, Campden.

It has been established that the ascospores of the fungus *Byssochlamys fulva*, which produces a spoilage of canned fruit, are present in many, and widely-distributed, fruit orchards. Increase in temperature was found to be more effective in killing the spores than increase in time of heating. Few individual spores resisted a temperature above 85° C., the majority of the spores being killed above 75° C.

Sterility was obtained in artificially infected cans of fruit by giving longer " cooks " than normally used, a higher internal temperature in the can being thus reached. This however involved the risk of destroying the texture of the fruit by overheating. The natural infection of the fruit was found however to be much less than the artificial infections used, so that the first could be overcome by a heating period which did not adversely affect the texture of the fruit.

Recommendations based on knowledge gained from the work were circulated to canners, and where these have been put into practice spoilage by the fungus has so far not appeared.

157. DISTRIBUTION OF SULPHUR DIOXIDE IN FRUIT PULPS AND JAM

BRISTOL UNIVERSITY.

A method of expressing the SO_2 content of preserved material in terms of " fixed " and " free " forms of SO_2 has now been satisfactorily developed and the difficulties of interpreting the results have been overcome.

The results indicate that a proportion of the SO_2 present is held in more or less loose chemical combination in compounds having properties similar in certain respects to aldehyde bisulphites.

The following results have been obtained :—

(i) When SO_2 preserved material is exposed to air, or treated as in the making of jam, either the whole or a proportion (depending upon conditions) of the " free " SO_2 is drawn off ; but much, if not all, of the " fixed " SO_2 remains behind in the product.

(ii) The two most important conditions affecting the proportions and removal of " free " SO_2 are temperature and pH.

(iii) In one experiment the proportion of fixed SO_2 present in pulp increased when fermentation was induced in the pulp.

(iv) As the pulp remains in contact with SO_2, the total SO_2 present in the pulp increases with time of contact only up to a certain point (about two days) ; thereafter the total amount falls, but the " fixed " portion of the SO_2 present continues to increase. This experiment is not yet terminated but has been in progress for 64 days.

A considerable amount of work is in hand at the present time on material prepared during the 1934 season, the following being the main investigations :—

(i) The determination of " fixed " and " free " SO_2 present in skins, seeds, juice and complete fruit of several different types of soft fruit.

(ii) A further experiment on the effect of fermentation on SO_2 content of fruit.

(iii) The effect of SO_2 in different forms, potassium or calcium salt or sulphurous acid, on the jellying power of the preserved fruit, and on the SO_2 content.

(iv) Examination of commercial samples of pulp.

158. DELAYED MATURATION OF MALTING BARLEY

Agricultural Engineering Research Institute,
Oxford University.

These investigations were started to try and find how far the malting quality of barley is affected by (*a*) the time of harvesting, (*b*) the method of harvesting, and (*c*) the conditions of artificial drying, i.e. effect of initial moisture content and temperature of drying on viability of grain.

Samples were collected from four farms in the neighbourhood of Oxford, beginning in July, 1934, and the results of the tests were as follows :—

Germination.—There was a gradual increase in viability up to 98-100 per cent. at harvest time ; but all samples, even the early ones, gave 98-100 per cent. germination after storage for four months. This suggests that for the barleys studied a period of after-ripening was necessary only if harvested too early. There was no difference between viability of grain harvested by combine and artificially dried, and that cut by binder and stacked, though some of the barley given a long sweat (48 hours at 100-110°F.) required a rest period of about a month before its full viability returned. In one instance a short drying in a hot air drier on the farm did not have this effect.

Moisture content.—There was a gradual decrease (apart from slight fluctuations due to dew and rain) up to the time of harvesting when an equilibrium value was reached. The point at which the low value was reached coincided with the first appearance of maximum viability.

1,000 *corn dry weight.*—There was an apparent sudden fall in dry weight per 1,000 corns just before harvest in all the barleys studied. This may have been due either to faulty sampling or to an increase in respiration, possibly with removal of sugars. The presence of the latter was found by Brown and Morris (1890) to inhibit the secretion of diastase by barley embryos.

X

MISCELLANEOUS

159. FLUCTUATIONS IN NUMBERS AND INCIDENCE OF DISEASE AMONG WILD ANIMALS

BUREAU OF ANIMAL POPULATION, OXFORD UNIVERSITY

An intelligence system has been maintained for receiving and investigating reports of fluctuations in numbers, and diseases, among wild animals. Several hundred reports were received this year. These dealt mainly with the American grey squirrel, now increasing again after a pandemic in 1930-31 ; the red squirrel, recovering also in numbers from a previous epidemic, but apparently influenced adversely in districts occupied by the grey ; voles, which fluctuate markedly and whose diseases have been investigated by the Bureau ; moles, studied by an annual transect in March from railway trains between Oxford and Chester, and Oxford and Norwich ; hedgehogs, among which local epidemics of unknown nature occur ; and hares and rabbits. A study of game animals and birds, which interlocks closely with this research, has also been carried out. The records obtained are being mapped and these show pronounced fluctuations associated with disease. These epidemics have received preliminary study.

160. MUSK-RAT INVESTIGATIONS

BUREAU OF ANIMAL POPULATION, OXFORD UNIVERSITY

Detection.—It is now possible to detect the presence of musk-rats with fair certainty, from the plants attacked, and the manner of attack. The habit of leaving bitten-off floating vegetation is distinctive among British rodents. On the most important food plant of Severn musk-rats (water crowfoot) no characteristic signs are left however. Wandering rats leave more obvious traces than those settled in a neighbourhood.

Habits.—Rats of all ages migrate in March, and large numbers are then caught. Immediately after this they settle down and breed, and the females probably retire to the deeper burrows for a time. Pregnancy lasts 28-30 days, and the usual litter is seven or eight (less in a first litter). The young may leave the nest after 3-4 weeks. There are two litters a year, in April and August : occasionally three : eight-months-old rats are mature.

There is a second migratory period in November, but fewer rats are caught than during the spring movement.

Distribution and trapping.—Musk-rats in the Shropshire area are now believed to be restricted to a stretch of 27 miles of the main River Severn; but they may occur further down stream than the recognised area. The present trapping methods have some drawbacks, and might well be supplemented by increased use of floating traps, and by the use of carbon monoxide gas.

A census method has been devised, based on the numbers trapped at different seasons.

Parasites and diseases.—A study has been made of parasites and diseases of the musk-rat in England, but few seriously affecting the health of the animal have been found.

161. BRACKEN INVESTIGATION

GLASGOW: WEST OF SCOTLAND AGRICULTURAL COLLEGE

Work was continued by the Botany Department during the year at Garelochhead and Auchincruive. At the latter centre the experimental and routine observations were recorded, and notes on work already accomplished were written up (1).

Experiments were also carried out on cutting with different types of machines and on spraying with a suitable herbicide from a land machine and from the air by means of an "Autogiro" machine.

Title of papers issued during the year.

1. Braid, K. W.: Bracken as a colonist. *Scott. J. Agric.*, **17**, 1, 59-70, 1934.
2. ———: History of the bracken disease. *Ibid.*, **17**, 3, 297-305, 1934.

162. *SPARTINA TOWNSENDII* (RICE GRASS) EXPERIMENTS

EAST ANGLIAN INSTITUTE OF AGRICULTURE, CHELMSFORD

Records, photographic and by measurement, of the experimental plantations laid down in previous years have been continued. From the data thus accumulated the conditions favouring and limiting growth are becoming more evident. In regard to the latter, an effort was made at Goldhanger to test some of the findings. This consisted in laying down a small plantation in an apparently critical situation.

At the same centre a series of plantings was begun in order to discover the time of year most favourable for planting offsets.

This series is being built up by planting about every four weeks on a uniform area.

Investigations into and tests of the quality and possibilities of seeds as a means of propagation are being undertaken both in the laboratory and in the field.

A survey of the natural *Spartina* areas of the south coast of England was made. This enabled a useful comparison between the environmental conditions of the south and east coasts to be obtained. The western natural limit of extensions still appears to be Poole Harbour and the eastern Rye Harbour. Specimens of *S. alterniflora* were taken from Southampton Water and successfully transplanted to Goldhanger, Essex, for observation purposes.

The experimental plantation in the estuary of the Forth, established by the late Dr. W. G. Smith, was inspected and found in a vigorous condition. Reclamations of foreshore areas have already been completed there and others are contemplated. When the former were made many of the plants were transferred to a new site on the mud-flats outside. Those left behind in the reclaimed area are still alive, but are meeting the competition of colonists from the mainland.

Establishment in the warm temperate zones overseas appears to have been frequently successful, under either the usual coastal conditions or inland on saline soils under irrigation, as in New South Wales (1). In the latter case the object is, of course, to increase the grazing area where the land is unfavourable to the ordinary herbage plants.

Only in one case, Honolulu, does *S. Townsendii* appear to have become firmly established in the tropical belt.

Title of paper issued during the year.

1. Bryce, J.: *Spartina Townsendii* and *brasiliensis* in warm countries. *Kew Bull.* (In the Press.)

163. INVESTIGATION OF SOIL PROFILES

School of Rural Economy, Oxford University

During the past year the collection of representative British soil type monoliths has been continued. Ten specimen monoliths have been obtained. These comprise, rendzinas 2, podsols 4, brown earth (or brown forest soil) 1, and salt marsh reclamation types 3. In addition to the above monoliths and samples connected with the study of the variations in morphological characteristics produced by utilisation and vegetation on acid soils have also been taken. The laboratory investigations are still in progress and will take a considerable time to complete.

APPENDIX.

LIST OF DIRECTORS OF RESEARCH INSTITUTES, ETC., AND HEADS OF ADVISORY CENTRES.

I. RESEARCH INSTITUTES, ETC.

A. Soils, Plant Nutrition and Plant Physiology.

Sir E. J. Russell, O.B.E., D.Sc., F.R.S.
Rothamsted Experimental Station, Harpenden, Herts.

W. G. Ogg, Esq., M.A., B.Sc., Ph.D.
Macaulay Institute for Soil Research, Craigiebuckler, Aberdeenshire.

R. G. Baskett, Esq., M.Sc., A.I.C.
Chemical and Animal Nutrition Division, Ministry of Agriculture for Northern Ireland, Queen's University, Belfast.

Prof. V. H. Blackman, Sc.D., F.R.S.
Research Institute of Plant Physiology, Imperial College of Science and Technology, South Kensington, S.W.7.

B. Plant Breeding, Crop Varieties and Seeds.

Sir R. H. Biffen, M.A., F.R.S.
Plant Breeding Institute, School of Agriculture, Cambridge.

Prof. R. G. Stapledon, C.B.E., M.A.
Welsh Plant Breeding Station, Agricultural Buildings, Alexandra Road, Aberystwyth.

W. Robb, Esq., N.D.A., F.R.S.E.
Scottish Society for Research in Plant Breeding, Craigs House, Corstorphine, Edinburgh, 12.

Ian W. Seaton, Esq., B.Sc.
Plant Breeding Division, Ministry of Agriculture for Northern Ireland, Stormont, Strandtown, Belfast.

W. H. Parker, Esq., M.C., M.A.
National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

T. Anderson, Esq., M.A., B.Sc.
Seed Testing and Plant Registration Station, Department of Agriculture for Scotland, East Craigs, Craigs Road, Corstorphine, Edinburgh, 12.

R. Rae, Esq., B.Agr., C.D.A.
Crop and Animal Husbandry Division, Ministry of Agriculture for Northern Ireland, Agricultural Research Institute, Hillsborough, Co. Down.

S. P. Mercer, Esq., B.Sc., N.D.A.
Seed Testing and Plant Diseases Division, Ministry of Agriculture for Northern Ireland, Queen's University, Belfast.

C. Horticulture and Glasshouse Crops.

Prof. B. T. P. Barker, M.A.
Agricultural and Horticultural Research Station, Long Ashton, Bristol.

R. G. Hatton, Esq., C.B.E., M.A.
East Malling Research Station, East Malling, Kent.

D. Boyes, Esq., M.A.
Horticultural Research Station, School of Agriculture, Cambridge.

W. F. Bewley, Esq., C.B.E., D.Sc.
Experimental and Research Station, Cheshunt, Herts.

Sir A. D. Hall, K.C.B., F.R.S., LL.D.
John Innes Horticultural Institution, Mostyn Road, Merton Park, London, S.W.19.

D. Entomology and Plant Pathology.

J. C. F. Fryer, Esq., O.B.E., M.A.
Plant Pathological Laboratory, Milton Road, Harpenden, Herts.

R. N. Salaman, Esq., M.D.
Potato Virus Department, Plant Breeding Institute, Cambridge.

Mrs. N. L. Alcock, F.L.S.
Plant Pathological Laboratory, Department of Agriculture for Scotland, Royal Botanic Gardens, Edinburgh, 14.

S. P. Mercer, Esq., B.Sc., N.D.A.
Seed Testing and Plant Diseases Division, Ministry of Agriculture for Northern Ireland, Queen's University, Belfast.

E. Agricultural Parasitology.

Prof. R. T. Leiper, M.D., D.Sc., F.R.S.
Institute of Agricultural Parasitology, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

The Lecturer in Helminthology.
Department of Helminthology, Department of Zoology, The University, Edinburgh, 9.

F. Animal Pathology.

Prof. F. C. Minett, D.Sc., M.R.C.V.S.
Research Institute in Animal Pathology, Royal Veterinary College, Camden Town, N.W.1.

Prof. J. B. Buxton, M.A., F.R.C.V.S., D.V.H.
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DEPARTMENT OF AGRICULTURE FOR SCOTLAND
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FOREWORD

In this volume is recorded the progress of agricultural research carried on with the aid of state grants in the United Kingdom during the year ended 30th September, 1935. It should be explained that only a brief summary of the work done can be included in the present publication. Those who desire further information about any part of the work should either consult the original papers published on the subject, a list of which is attached to each report, or alternatively enquire of the Director of the institution concerned. A list of Institutes, giving the names and addresses of the directors, forms an appendix to the volume.

Reference should also be made here to the work of the Agricultural Research Council. The Council was established by charter in 1931, primarily as a body of men expert in the sciences underlying agriculture, to advise the Departments of Agriculture and the Development Commission on the co-ordination and conduct of the research aided by them. In addition, the Council has funds at its own disposal for the conduct of research and for aiding investigations at centres outside the " grant-aided lists " of the Departments. The present volume includes reports on a number of investigations, particularly in the field of animal diseases, which have either been initiated by the Council, or by the Departments of Agriculture at the Council's suggestion. The Council's published reports contain a general survey of agricultural research in Great Britain, with an account of the Council's activities.

The research activities of the Agricultural Advisory Officers are also recorded in this book. As a necessary part of their work these officers carry out investigations into problems of local interest and importance. Farmers and others requiring advice on agricultural and horticultural matters are reminded that by applying to the Agricultural Organiser for their county they can have placed at their disposal the fruits of experience and research, which have been accumulated by the research and advisory services.

Ministry of Agriculture and Fisheries,
10, Whitehall Place,
London, S.W.1.

May, 1937.

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I RESEARCH INSTITUTE INVESTIGATIONS

SOILS, PLANT NUTRITION AND PLANT PHYSIOLOGY

1. ROTHAMSTED EXPERIMENTAL STATION

Crop Production.

During the past few years many experiments have been made to investigate the response of the more important crops to fertilisers. Much work has been done in the chemical, botanical and field experimental departments and the information obtained has been disseminated among farmers, fertiliser manufacturers, agricultural experts and others interested. It has influenced fertiliser recipes and practice and enabled farmers to obtain better crops at little if any more and often less expenditure.

The experiments show, however, that on our present methods the farmer recovers only a small part of the fertiliser used. Of the nitrogen applied, even in the most efficient fertilisers, not more than 40 to 60 per cent. is recovered, and the lower figure is more usual than the higher. Recovery of phosphate is smaller and has not exceeded 25 per cent. even on grassland, and after residual effects have been taken into consideration. Numerous experiments are now being made to explore the possibility of a better utilisation of the fertiliser, and in the recent experiments on sugar beet and potatoes the fertiliser tests are usually combined with cultivation tests such as time of sowing, width of spacing, method of placing manure, etc. A number of these experiments are made not only at Rothamsted and Woburn but at outside centres also, and they are rendered the more important because so far the sugar beet crop commonly fails to respond adequately to the fertilisers used, though for what reason is not yet clear (29).

As in previous years, a number of grassland experiments have been carried out in different parts of the country to compare the values of the different types of basic slag now available or likely to become so, and also to study the effects of a cheaper material, mineral phosphate. With the taking over of a considerable area of additional grassland in 1934 it has become possible to arrange for grassland experiments to be made at Rothamsted also, and plans for these are being worked out. Unfortunately it has not yet been found possible to design a completely satisfactory grazing experiment: the older types of experiment do not satisfy modern statistical tests. An attempt is being made this year to overcome the difficulty of a combination of grazing with frequent cutting and analyses of herbage from small isolated but randomised areas of the field.

Problems arising out of the mechanised cultivation of arable land continue to receive attention. Both at Rothamsted and at Woburn deterioration of yield has followed from continuous growth of cereals on the same land where only artificial fertilisers are used, but the yields have been better maintained with farmyard manure. On the lighter soils, such as those on which mechanisation is likely to be practiced, the supply of organic manure is very important, and numerous experiments are being made in connection with this subject. Green manuring is uncertain in its action, and even occasional clover residues, while good for a time, do not seem to be indefinitely effective. In the Fermentation Department much work is done on the rotting of straw and other vegetable products to produce a good manure (2, 3, 4, 5, 6). Organic manures, so far as they have been tested, have less fertiliser value than the equivalent dressings of inorganic fertilisers. Neither at Rothamsted nor Woburn, were diseases or pests important, even after many years of continuous wheat growing. But in 1935 complaints reached us from mechanised farms of serious disease trouble even after 3 or 4 years only of wheat growing. This trouble has been found to be due to Takeall (*Ophiobolus*) or to *Fusarium*. By a curious coincidence, none of the three classical continuous wheat fields is liable to these diseases (though Takeall appeared at Woburn near the end of the experiment) but the light chalky soils on which mechanisation is developing are more susceptible to them. This question is being further investigated.

Fallowing is, however, very effective in restoring productiveness to land deteriorated by continuous cultivation, though it is only temporarily beneficial. It makes a better preparation for wheat than clover or temporary leys. Weeds, however, must be kept down, and a study has been made of the conditions under which this is best done for the more important species. Chemical spraying methods are being tried, and a series of experiments has been started, with quite interesting results so far, on the possibility of removing weeds from grassland by spraying.

The cultivation experiments have continued, and an extensive series of observations on rotary cultivation is being worked up.

The effect of spraying various crops with solutions of ammonium thiocyanate was studied. Some showed more or less severe injury after spraying, but those which survived benefited from the extra nitrogen, while a good control of weeds was effected. The treatment seems promising for weedy grassland.

The value of the field experiments has been much enhanced in recent years by the improvements in the design continuously made since R. A. Fisher introduced the new principles of statistical control. A 27 plot test has been worked out which is convenient in use and valid in principle, and is capable of giving a great deal of information of a known degree of reliability. For other cases, other methods such as Latin squares, randomised blocks, etc., have been worked out, and formulae have been designed and tested for dealing with such accidents as the loss of produce of one or more of the plots: frequently a great deal can be saved even though the accident may have deprived the experiment of its full value (37). On the other hand, observers' bias (even when wholly unintentional) is shown to contribute a large element of error in some of the older methods of working. These new methods have been taken up vigorously by overseas experimenters and are adopted for most of the important new experiments in the tropical parts of the Empire and other countries where British workers play much part: for example in Malaya on rubber, in Ceylon on tea, and in Egypt on cotton. Numerous overseas workers come to Rothamsted and study the methods, applying them to their own experiments, or to the detailed examination of results they have already obtained.

SOILS.

The chemical and physical work consists in attempts to discover the composition and constitution of the soil, and to follow the changes taking place therein. The clay is recognised as one of the most important components and much work is being done on it. With fuller knowledge, it should be possible to understand the great agricultural differences that exist between a heavy Clay-with-flints and a Lower Lias clay soil. A particular case on which much work has been done is the comparison of the red and black soils which, in tropical countries, often lie side by side, and differ widely in agricultural value though they behave alike to laboratory tests, reminding us sharply that soil chemistry does not yet adequately describe the soil as a crop producing agent. Much work has also been done on the old problem of finding some chemical means of forecasting the probable effects of fertilisers. For soils suffering from some serious deficiency this is relatively easy, but for soils that have been reasonably well farmed and manured none of the present methods is adequate.

Numerous chemical and physical methods have been proposed in various countries for characterising soils for mapping purposes, or to explain their behaviour on cultivation and cropping or the changes which they have undergone.

Promising methods are critically examined with the view of forming a collection that can be confidently recommended for use by soil workers. Some fail to stand the test: in particular the oxidation-reduction potentials much used in soil investigations by some workers do not appear to have the value credited to them.

Considerable progress has now been made towards the straightening out of the difficult problems associated with the moisture relationships of the soil (3). For many years these have caused considerable difficulty: a scale has now been devised which introduces the same kind of order and simplification as the pH scale has done for soil acidity.

The physical conditions associated with tilth are also being studied.

Composition of Crops.

In modern conditions quality of crops is of considerable importance, and while this is assessed for practical purposes by buyers' marks these give no satisfactory information because they do not show with sufficient precision what exactly the producer must supply. Further they give no information about grass and fodder crops. Chemical examination is therefore made in the Biochemical Section. A beginning has been made with ryegrass, and this is shown to contain a substance which easily yields fructose, a sugar of potential commercial value since it is twice as sweet as cane sugar. The so-called "crude fibre" also has been examined (77), and also the properties of the cell wall constituents. This work links up closely with that of the Fermentation Department on the rotting of straw.

Soil Microbiology.

The work consists in the study of the soil micro-organisms, and an important event of the year was the drawing together of the results of several years of work into a Rothamsted monograph which is now published. Much of the work of the General Microbiology Department is concerned with the purification of rural factory effluents which is reported separately. In the Biological Department the work on clover organisms continues, and it is shown that in the soils of certain hill districts there occur harmful strains which prevent the clover plants from developing. Other strains are more potent and a few are sufficiently so to be able to overcome the harmful effects of the bad strains and enable the plant to make full normal growth. Experiments have been begun on the inoculation of these beneficent strains, and the results are distinctly promising. The first essential is a survey of the hill districts to see how far these harmful strains are prevalent, and to what extent the highly efficient strains already isolated are able to act in overcoming their bad effects.

PLANT PATHOLOGY.

Advances have been made in the study of virus diseases of plants. Small quantities of copper salts introduced into the plant produced symptoms resembling those of virus diseases, though the phenomena differ from those produced by molybdenum salts. Inoculation with a strain of virus conferred in certain conditions some degree of immunity against a virulent strain of the same or a closely allied virus. Considerable information is being obtained about the power of infection possessed by aphids that have fed on infected plants for various lengths of time: even 2 minutes feeding gives this power of infection, but it persists only for a short period.

ENTOMOLOGY.

The main work of the department is the investigation of the causes of the rise and fall of insect populations and of their movements by migration (58, 59). Methods have been devised for making sample censuses that can be subjected to statistical examination and these are continuously improved to facilitate their use in practice. Approximately four times as many insects were caught from March to October in 1935 as in the corresponding period of the previous years, the difference being mainly in the Lepidoptera and the Diptera. Full meteorological observations are taken, and relations are sought between these and the census figures.

Work on gall midges (62, 63) and other insects of economic importance has continued.

The work on bees attracts much attention from bee keepers, who contribute one half the cost of the disease investigations, the money being collected by the Bee Associations. The work falls into two parts: studies on the bee in health and of honey production; and the diseases of bees. Some of the results were presented to a Conference of bee keepers held at Rothamsted last summer, this being by far the largest attendance we had ever had. Special attention has been devoted to the swarming of bees and to a scheme for voluntary insurance against bee diseases.

INSECTICIDES.

A study is being made of the chemical evaluation of the insecticidal value of the " fish-poison " plants, especially derris. A number of recommended methods have been compared with the result of biological tests, but none of them has been found to give satisfactory results with all varieties of derris. The difficulties seem to be due to changes occurring in the toxic compounds (rotenone and others) in the processes of extraction from the plant (70, 71, 72, 73, 74).

Experiments on the hybridisation and on the cultivation of pyrethrum (*Chrysanthemum cinerariaefolium*) have been continued, but adverse weather conditions made the 1934-35 results practically valueless. Methods of evaluating the pyrethrins are being compared.

Research on soil fumigation is now being undertaken, and a technique has been devised for rapidly separating the insects and soil fauna from a sample of soil, by stirring the sample in a special non-toxic solution, and bubbling air through the mixture. The insects, etc., and other light material are carried up to the surface and separated out. Field experiments have been carried out on fumigation against eelworm and wireworm. Some of the fumigants used in the concentrations applied decreased the yields, but carbon disulphide jelly (for eelworm), chlorpicrin (for wireworm), and certain proprietary mixtures have given promising results.

THE FARM.

Besides the commercial work of the farm and the experimental plot work—for which, however, there is a special supervisory staff—certain investigations are carried out of practical rather than scientific interest on the management of sheep for lamb production; the management of pigs for bacon production; and the comparison of fuel with electricity as source of power about the buildings. A small Diesel engine has recently been lent us by the makers to see how it compares with the more usual types. These measurements are done in consultation with the Oxford Institute of Agricultural Engineering.

Titles of papers issued during the year.

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CROP WEATHER SCHEME.

86. Sampling observations on wheat. *J. Min. Agric.*, **41**, 1152-1154, March; **42**, 211-214, June; 528-531, Sept.; 642-644, Oct., 1935.

2. MACAULAY INSTITUTE FOR SOIL RESEARCH, ABERDEEN

Soil Classification and Surveys.

(i) *Eastern Kincardineshire.*—The field study of the soils of this area has been practically completed, descriptions of typical soil profiles having been made and samples of these collected. The survey is being carried out on the scale of 1 inch to 1 mile and it has been found that the differences in various geological formations are reflected in the soil types found.

The laying down of an electrical transmission line in the northern part of the area furnished means of obtaining samples from profiles to a depth of 7 feet. Chemical and mineralogical analysis of certain of these soils have been made.

(ii) *North-west and Central Highlands.*—The chemical and mechanical analyses of the soils collected during the summer of 1934 was commenced and a large part completed (1). A selection of the results on uncultivated soils has been written up, and submitted to the journal " Forestry " for publication.

A spell of nine weeks was spent in the field in the Huntly district. An area of about 36 square miles was mapped, and a set of soil profiles collected are now being analysed.

(iii) *Aberdeenshire.*—The pits dug for the transmission line from Park to Huntly provided opportunities for obtaining a representative collection of profile descriptions and samples over this area. Geologically the area from Park to Kintore resembles Northern Kincardineshire, being formed of gneisses, schists and large areas of granite, generally covered by glacial deposits.

Between Kintore and Huntly the rock areas include hornblende schists, gabbros and norites, and slates. A number of these soils have been analysed (2).

(iv) *Areas in Renfrewshire.*—The study of one or two areas in Renfrewshire on the scale of 6 inches to the mile has been continued.

Geological Work.

The laboratory study of soils in connection with the soil survey work was continued and the nature and proportion of the minerals present in the soils determined. The results of this study of the soils of south and north-east Scotland were incorporated in a paper presented to the Congress of the International Society of Soil Science (5).

Soils collected by other workers in connection with soil surveys or advisory work were also examined and reported on in preparation for further chemical investigations.

Soil Fertility Investigations.

(i) *Field and Pot Mitscherlich Trials.*—In the selection of methods for use in advisory work the procedure outlined in previous reports has been continued, viz. field experiments designed to estimate deficiences in the common plant foods are laid down at selected centres; samples of surface soil to the normal plough depth are taken from the experimental areas for examination in pots and at the same time samples of both surface soil and subsoil are taken for analyses by different laboratory methods. Those laboratory methods which give results agreeing most closely with the results of the field and pot experiments on any soil type are then used in the testing of similar soils for advisory purposes. From the results of fertility investigations it was evident that the nutrient content of the subsoil is an important factor in plant growth on many of our Scottish soils and as indicated in last year's report an examination of samples of subsoil as well as of surface soil is now included in advisory work.

In 1935 field experiments designed to estimate the amount of plant food in a soil were laid down at 25 centres throughout the country. These soils were also examined in pots by the Mitscherlich method and samples of the surface and subsurface layers of all the soils were taken for examination by laboratory methods. An account of typical results obtained in previous year's series was given in a paper which was read at the International Soil Society Meetings at Oxford in August (6).

(ii) *Liming Experiments—Jointly with North of Scotland College of Agriculture.*—In order to study the effects of lime on crop yield and on soil properties a series of liming experiments was undertaken in conjunction with the North of Scotland College of Agriculture. The suitability of the soil as a centre for liming and the quantities of lime to be applied were determined by preliminary soil analyses. Early in 1935 liming experiments were laid down by the county organisers at 14 centres in the North of Scotland. In each case yields of the following crops will be determined in the experimental areas: Turnips 1935; Oats or Barley 1936 and Hay 1937. Samples of soil will be taken for analysis periodically.

(iii) *Field Experiments with Basic Slag.*—In 1934 field experiments were undertaken in conjunction with the Permanent Committee on Basic Slag. Crop yields for swedes were obtained at three centres in the North of Scotland and the results have been incorporated in the 13th Interim Report of the Permanent Committee. The yield of oats in the experimental plots was determined at one of the centres in autumn 1935. The changes produced in the soil are being studied.

(iv) *Craibstone Soils.*—Samples of soil are being taken periodically from field experiment plots at Craibstone, the experimental farm of the North of Scotland College of Agriculture. These plots are subject to controlled manurial treatment and the changes in the soil are being followed.

(v) *Composts.*—Several composts were also studied in pots and it is hoped to correlate the response in plant growth with the method of preparation of the compost.

(vi) *Joint Work with Forestry Commission.*—Soil samples were examined from various nurseries on which the Forestry Commission wished to carry out manurial experiments. On the basis of the analytical results obtained basal and experimental manurial dressings were drawn up and experiments are being conducted in conjunction with the Forestry Commission with a view to determining the amounts of the various plant foods necessary to constitute a reasonably fertile nursery soil. To supplement the experiments which were commenced last year it is intended to carry out liming experiments on very acid soils at five centres.

The Study of Peat Soils.

(i) *Macaulay Demonstration Farm, Lewis.*—During the year satisfactory progress has been made at the farm and good crops of hay and silage have been grown. The pasture land, too, continues to give good results and additional areas of the moorland have been improved for pasture by manurial treatment and seeding. There is a demand for the milk produced at the farm and the poultry unit has been increased in size. Sheep have been kept during the year and a few pigs have been purchased recently.

Unfortunately very little experimental work has been carried out on account of lack of funds. Experiments on peat draining have been continued and a few tests on the improvement of moorland by simple methods of treatment have been carried out. An account of the work done in Lewis was published (7).

(ii) *Survey work.*—During the year the field survey of peat land has been extended and a complete examination of a number of typical areas carried out. These include peat-mosses in Lanarkshire, Mid and West Lothian, Stirlingshire, Kincardineshire, Aberdeenshire and the Isle of Lewis. A classification has been drawn up (8).

Pollen analytical work has been curtailed, but a few samples of particular interest were examined.

(iii) *Land reclamation.*—An intensive survey of several large peat areas in Lanarkshire and the surrounding counties was undertaken. Some of the survey details have been incorporated in the paper already mentioned (8), and full reports on drainage, liming and manuring cultivation and cropping have been submitted.

(iv) *Laboratory work.*—Chemical and physical analysis of peat soils has been continued in conjunction with the survey and fertility work. An endeavour is being made to assess the effects of humification on the physical properties of peat soils.

The work on the chromic acid method for the determination of carbon (9) has been completed and published, whilst a paper on the application of this method to the determination of nitrogen has also appeared (10).

Craibstone Lysimeters.

The study of the composition of the drainage from the soil of the Craibstone Lysimeters has been continued during the year 1935. The crop during the year was yellow turnips (Balmoral) sown on 21st May with the following manurial treatment, per acre, given to lysimeters Nos. 2 and 3—dung, 12 tons; sulphate of ammonia, 1 cwt.; superphosphate, 4 cwt.; steamed bone flour, 1 cwt.; muriate of potash, 1 cwt. No. 1 was as usual unmanured. In preparation for this crop, ground lime, at the rate of 2 tons carbonate of lime per acre, was applied to No. 3 when the plots were dug over at the end of October, 1934.

As in previous years the volume of the drainage from each lysimeter was measured daily, and the composition of the waters determined monthly. During the first few months of the year the drainage came through slightly opalescent with very fine suspended colloidal material: then came two or three months when the waters were free from this. Towards the end of September, when there was considerable rainfall, the amount of suspended material was greatly increased, especially from the unmanured lysimeter No. 1. The turbidity imparted to the waters has since become less, being very slight in Nos. 2 and 3, and that in spite of very heavy rainfall. After removal of this colloidal material by means of a membrane filter its composition is being determined. In previous years the material was separated by flocculation with dilute hydrochloric. As it appears possible that the small quantity of acid coagulant used may be sufficient to bring about the partial displacement of that fraction of the bases which may be carried down in absorbed form by the colloidal material, determinations are being made of the composition of this material after removal by the two methods (12).

The turnip crop on each lysimeter will be weighed and determinations made of the ash constituents.

Special Investigations.

(i) *Soil organic matter.*—The investigation of organic constituents of some typical soil profiles from the north-east of Scotland has been completed (13).

(ii) *Pasture experiments.*—The pasture investigations undertaken jointly with the Edinburgh and East of Scotland College of Agriculture have been continued. A paper on flushing of grassland has been completed and experiments have been laid down at various centres in the south-east of Scotland to study pasture reversion.

(iii) *Spectrographic analysis.*—During the year an extremely valuable piece of new apparatus, viz., a Lundegardh apparatus for quantitative flame spectral analyses has been installed. Up to the present work has been limited to a study of the technique of using the instrument, and standardising it, as a preliminary to its use for soil analysis.

Titles of papers issued during the year.

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8. Robertson, I. M., and Fraser, G. K.: The classification of moorland in Scotland. *Trans. Int. Cong. Soil Sci.*, **1,** 418-419, 1935.
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13. Shewan, J. M.: On the chemical composition of the organic matter in Forest soils. *Ibid.*, **I**, 377-378, 1935.
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3. CHEMICAL (AND ANIMAL NUTRITION) DIVISION

MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

Soils and Fertilisers.

Lime requirement and soil acidity.—The work outlined in last year's report has been continued. Data on the lime status of some 600 soils have now been obtained.

The effect of lime on crop yield and composition has been studied in some detail for a number of these soils. A full report of the work will be published in due course.

Nitrogenous manuring of grassland.—An experiment was begun in the spring of 1935 to obtain information on the following points:—

(i) The effect of sulphate of ammonia on the yield of dry matter and protein per acre and on the length of the growth season.

(ii) To compare different rates of application of sulphate of ammonia.

(iii) To compare application of sulphate of ammonia in two doses with applications in three doses per annum.

The yields were measured by recording the weight of mowings at intervals which varied according to the growth of the pasture. It is hoped to continue this experiment for several seasons.

4. RESEARCH INSTITUTE OF PLANT PHYSIOLOGY, IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Vernalisation experiments.—Experiments were continued with Petkus winter rye. (i) The effect of time of application of low temperature was studied in some detail. Time-periods from four days to seven weeks were used. It was found that four days cold had no effect, but seven days already showed some acceleration in the differentiation of the flowers. This acceleration was increased progressively up to five weeks exposure; longer exposure had no further effect on flower production though some reduction in tillering occurred. (ii) The after-effect of short days was studied. The exposure to short days ranged from one week to eight weeks. After three months those plants which had initially received one week of short days showed signs of flower differentiation, while those with six and eight weeks short days at the start had been vernalised by short days and were in flower after five months. A great delay in " shooting " even in these plants had occurred, as flowering normally takes place in ten weeks. It was found that the leaf number in all these plants was high, only a small reduction in the longest exposures to short days was noted (25-22 leaves). The main effect of short days is merely an acceleration in growth of the vegetative point, and hence an acceleration in flowering. This agrees with previous findings. (iii) Some work has been done on vernalisation of millet by high temperature as recommended by Lysenko. No effect was obtained. In short days a considerable acceleration of flowering occurred accompanied by reduction in leaf number. (iv) A large number of varieties of Sorghum were grown to test the specificity of the total number of leaves produced. It was found that the varieties were constant in leaf number within narrow limits, and in general small leaf number was associated with early flowering. (v) Four varieties of wheat were also tested. It was found that the vernalisation technique with reduced water supply gave rather worse results than simple exposure to low temperature. The expected leaf-number-relation was found.

Effects of mineral deficiency on barley.—A further study was made of the relation of phosphorus deficiency to the respiration rate in the leaves of barley. For this purpose the method of feeding detached leaves with nutrient solutions was again employed. Leaves were removed from the plants at four different times during the growth period and different batches of comparable leaves fed in the following manner: (i) water alone; (ii) sucrose alone, 1 per cent. solution; (iii) sodium phosphate (two concentrations) plus sucrose; (iv) sodium phosphate (two concentrations) plus sucrose plus ammonium nitrate. The leaves after removal from the plant were divided into six batches which were then allowed to respire for six hours and the carbon dioxide estimated. After this they were fed with the nutrient solution detailed above by inserting the cut ends into the solutions (60 ccs.) and allowing the nutrients to enter by transpiration. Respiration estimations were continued for a further two to three days. In some cases the leaves were injected with the solutions, and then allowed to clear themselves by transpiration before replacing them in solutions in the respiration chambers. As it was found that the preliminary injection, even of water, increased the subsequent respiration, injection was abandoned.

Simultaneously with the estimation of respiration, changes in the nitrogen metabolism were studied. A preliminary estimation was made, on samples of leaves comparable with those used for respiration, of total nitrogen-content, total amino-nitrogen, total crystalloid nitrogen, and protein nitrogen. At the end of the respiration period the leaves removed from the chambers were again analysed for nitrogen as above. The aim of the experiment was to determine whether changes in respiration induced by phosphorus feeding were related to protein synthesis or degradation. The following results were observed: (i) a small increase in respiration resulted from feeding with sugar alone; (ii) a large response from feeding with phosphate and sugar occurred, but the magnitude of the response differed with the age of the plant; it was greater in leaves in the early stages of the plant before symptoms of phosphorus-starvation had appeared; (iii) a further increase in respiration also occurred on adding nitrogen, but only in the later-formed leaves. Protein hydrolysis was reduced by addition of ammonium nitrate. No simple relation exists between nitrogen changes and carbon dioxide production. Analysis of the leaves showed that phosphorus had entered the leaf during feeding and the amount entering was greater in the early leaves than in the later.

Effect of mineral deficiency on rye.—A large experiment was carried out with rye to test the following points:—

(i) The relation of vernalisation to the manurial supply.

(ii) The effect of potassium deficiency on the growth and water-content under conditions of high calcium, high sodium, and balanced calcium and sodium. This covered the same ground of the previous year's experiments with barley.

(iii) The effect of the level of phosphorus on the relation of potassium starvation to calcium and sodium. In general the results with rye agreed with those already noted with barley. Water-content may be either increased or decreased by potassium starvation, the effect depending on the levels of calcium and sodium. Rye appeared to be intolerant of calcium; this was not a direct effect of pH as this was adjusted.

The vernalisation effect was independent of all manurings, in no case could flowering be induced by manurial deficiencies with winter rye. Rye plants differ from barley in that ear production and fruit formation can take place normally even at very low levels of potassium and stem elongation is not inhibited as in barley. The usual studies were made of tiller production, leaf growth and dry weight increase.

Electroculture.—The electroculture investigations have been carried out on the same lines as last year, and in addition some experiments have been made with wires charged to 30,000 volts. The effect of the discharge on a mixture of perennial rye-grass and late flowering red clover has also been investigated. In no case has any significant difference been obtained between the experimental and the control plants. It is not proposed to continue the experiments in 1936.

Physiology of Tomato Seedlings.—The work on tomato plants carried out at the Cheshunt Experimental Station has been continued and as in previous years has been confined to seedlings (variety E.S.1.) with no more than 10 expanded leaves. The methods previously described have been applied to the further study of the assimilation and of the movement of assimilated material from the leaf-system to the stem and root. Some investigation of the water relations of the seedling has also been made. The technique is also being modified with the view of studying the movement of organic matter within the leaf-system.

Some of the more important results indicated by work carried out during the year are given below. The seasonal differences ("hard" and "soft" plants) observed in seedlings obtained from sowings made at different times of year, namely differences in rate of assimilation, in the ratio of leaf weight to weight of stem and root, in the water-content of the plant, etc., are shown to be the result of a number of factors of which the most important, under commercial conditions of culture under glass, are light intensity and day-length. An approximate estimate has been made of the total light energy falling on seedlings during the growth period from seed to the eight leaf stage throughout the year and it has been shown that the assimilatory efficiency of the plant falls with the seasonal increase in light intensity and in day-length. A number of determinations have been made of assimilation rate and of the percentage of assimilate passing from the leaf-system to the stem and root, and it has been shown that more than 80 per cent. of the total amount of assimilate moved out of the leaf-system takes place during the illuminated assimilation period. The magnitude of the fraction passing out during the day period is partly determined by "seasonal" effects, either light, temperature or the past history of the plant.

Very little information is yet available as to the movement of organic substances from leaf to leaf, i.e. within the leaf-system. The movement of such substances is now being investigated in order to obtain some understanding of the effect of environmental factors on the form of the plant and its response under cultural conditions. Some of the water relations have been investigated and an indication has been obtained that there may be some connection between the supply of water to embryonic tissues and the supply of organic matter. Indications have also been obtained that leaf expansion is largely predetermined during the day but in summer it does not occur until after sunset owing to the lack of sufficient water.

Sugar Beet Investigation.—Work on this investigation, which has been carried out in co-operation with Rothamsted Experimental Station, has been continued. There are still a large number of sugar analyses to be undertaken.

Titles of papers issued during the year.

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3. Baptiste, E. C. D.: The effect of some cations on the permeability of cells to water. *Ibid.,* **49,** 345-366, 1935.
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8. Ernest, E. C. M.: The effect of intercellular pressure on the suction pressure of cells. *Ibid.,* **48,** 915-918, 1934.
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12. Portsmouth, G. B.: The effect of ionised air on the respiration of green plants. *Ibid.,* **48,** 1013-1027, 1934.
13. Purvis, O. N.: An analysis of the influence of temperature during germination on the subsequent development of certain winter cereals and its relation to the effect of length of day. *Ibid.,* **48,** 919-955, 1934.
14. Selman, I. W.: Some aspects of the water relations of tomato plants. *20th Ann. Rep. Cheshunt Exp. Sta.,* 89-94, 1935.
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PLANT BREEDING, CROP VARIETIES AND SEEDS

5. PLANT BREEDING INSTITUTE, CAMBRIDGE UNIVERSITY

Owing to the very mild winter of 1934-35, and the dry summer which followed, it was impossible to test the resistance of crops to adverse weather conditions, and the value of the yield trials was doubtful. Further, the commoner cereal diseases were practically absent, and selections for resistance to yellow rust and to mildew had to be made on seedlings inoculated under glass.

Wheat.—The only complication met with in the routine portion of the 1935 programme was the occurrence of rogues in several of the multiplication plots. These were, almost invariably red chaffed, red grained and semi-dense in ear shape, whereas the forms being multiplied were generally white chaffed, white grained and dense; this suggests that the rogues were due to out-crossing. Such rogues even occurred in a small nucleus stock raised from a dozen single plants each of which had been rubbed out separately. But curiously enough the crop grown from the bulk from which these had been selected was rogue free.

This red-chaffed type of rogue has during the past three seasons taken the place of a rough-chaffed rogue which previously was equally prevalent in the multiplication plots. Another rogue phenomenon, the occurrence of reddish grain in presumably pure white forms, cannot be explained satisfactorily by outcrossing, and is being investigated.

Work on the production of wheats with a larger number of grains per spikelet has been continued. Wheats of this type had already been produced, but were valueless owing to the linkage of the "free-setting" character with one causing severe shattering of the ear. In the F_3 generation some free-setting non-shattering plants were found, and these have bred true. They are very promising forms, and will be grown on in 1936.

The study of crosses between early and late-ripening wheat has been continued, and it is found that the range of early and late types in F_2 and F_3 exceeds the difference between the parental forms. A detailed investigation of the inheritance of quality, using crosses between Yeoman II and Wilhelmina, is also continuing. Segregation appears to follow the simple lines seen in the earlier Red Fife crosses. The Yeoman II × Wilhelmina cross is also the basis of efforts to produce a short-strawed wheat specially suited for combine harvesters.

Little has been obtained from the work on genetics of disease resistance, owing to the low incidence of diseases in the last three seasons. The only results obtained were from inoculation experiments on seedlings under glass. Supplies of seed of the last adequately tested generations are now exhausted, so continuation of the work depends on selections made on scanty data.

Malting barleys.—The very tentative selections made in 1934 on the F_3 material raised from back-crosses between some of the best barley varieties now in cultivation and their parents were grown in 1935. Owing largely to unfavourable weather conditions, only about 5 per cent. of the selections are unquestionably superior to the average. Some of the selections, however, showed, what to the maltster and brewer is an improvement in grain shape, a feature that cannot be overlooked even if it is unassociated with any advance in intrinsic quality.

The critical quantitative and qualitative comparisons of the Spratt-Archer re-selections were continued in 1935. The results of the malting tests conducted in 1934 indicated the decided superiority of certain forms, notably those which had exhibited distinct earliness in ear-emergence and earliness in ripening in 1933 and 1934 and again in 1935. The most promising of these particular forms was included in a Latin square trial this season, and its produce, together with that of all the other selections, will be submitted for malting trials in a few weeks time. The grain yield of the early form referred to was equal to that of the highest yielding form for the past three years.

In 1933 the early ripening form of Spratt-Archer was crossed with Spratt and several F_2 generations were raised this year. It is hoped to be able to prosecute observations on the F_3 generation in 1936 with special regard, amongst other desirable features, to the appearance of still earlier ripening forms.

Two-row malting barleys.—Five selections were again tested in 1935. Two narrow-eared selections have proved themselves consistently good yielders over three years, and, judged on Nitrogen percentage and appearance, their quality promises well. These two selections are undergoing malting tests, and if these prove satisfactory, the stocks will be multiplied.

The remaining three selections are broad-eared, and they are to be tested finally against a broad-eared standard in 1936.

Six-row malting barleys.—Single plant selections have been made from the F_3 of crosses between six-row barleys and the two malting barleys Spratt-Archer and Plumage-Archer. Only six-row segregates have been kept, and the basis of selection has been largely on grain size, uniformity and quality; tillering; and strength of straw. Great improvement has been obtained in the grain characters compared with the six-row parents. In addition, selection of large-eared, coarse-grained, strong-strawed plants suitable for feeding, and drainage in brewing has been practised.

Two-row winter barleys.—Single plant selections were made in 1935 from the F_2 of crosses between winter-hardy, strong-strawed barleys and the best English malting barleys. None of these selections appears to be of first-class malting quality, but they combine some quality with distinct promise in hardiness, strength of straw and yield.

Two-row early-ripening malting barleys.—Early selections which possess fine, strong straw, well-shaped ears, and promise of quality, have been made from crosses between Kenia and Spratt-Archer, Plumage-Archer, Chevallier, Archer and Goldthorpe.

Barley genetics.—The inheritance of time of ear emergence, rachilla length, fertility of the lateral florets, hoods, awns and awnlessness, waxiness and pigmentation, are being studied.

The only character which has been studied sufficiently fully to warrant any conclusions is that of time of ear emergence. The several crosses studied appear to show that the nature of the inheritance depends primarily on the reaction of the parents to length of day and temperature. Ear emergence is therefore not a single physiological character, but is a manifestation of these two characters at least. In no case was it found possible to reconcile the results obtained with any simple Mendelian hypothesis.

Oats.—The hybrid Resistance (Argentine x Grey Winter No. 136/17) was placed on the market by the National Institute of Agricultural Botany in the autumn, 1934. To study a slight variation observed in the shape of the ear, a large number of single plant cultures was selected in 1933. These were grown in 1934 and again in 1935. From these cultivations it is clear that differences of a genetic character do exist, and it is now proposed to increase the best of these reselections.

The small scale quantitative tests this season comprised the following:—

Comparisons of (i) Grey Winter, Resistance and three hybrids of Argentine x Grey Winter; (ii) six selections of the (?) mutation which arose in one of the new winter oats in 1928; (iii) Victory and two of Dr. Cunliffe's new frit-resistant varieties.

The first series again demonstrated the superior yielding capacity and good straw of Resistance and the three cultures of another selection made from the same cross, and have furnished results which differentiate the latter.

The second tests show that the oats of this series are high yielding forms with distinctly good straw and at the same time produce grain of high quality. Low temperature tests and field tests made with these oats at Svalöf have demonstrated a winter-hardiness which in some cases is superior to Grey Winter—at present the standard for winter-hardiness in oats in this country.

In the hope of improving the quality of grain in Resistance, that variety was back-crossed with Grey Winter in 1929. From the F_3 (1932) onwards the produce has been repeatedly selected until this season there was in hand about 20 selections which, while maintaining the character of Resistance straw, did produce a more desirable grain. This season the number has been reduced again, this time to six, and these will be tested out quantitatively in Latin squares sown this autumn.

Other crosses of Resistance with selected varieties were grown in the F_2 generation this year, and the most promising plants originating therefrom will be sown this autumn so far as time and space permit.

Although there is no greater intrinsic value in large-grained oats as such than in small-grained oats, there is a commercial demand for the former. It may be desirable to meet this strong preference, and with this in view crosses of Resistance and other varieties have been made with a large-grained derivative of Grey Winter x Black Winter x Red Algerian.

The F_2 generations of Argentine x Mesdag (Grey Spot resistant) and of Fyris (resistant) x selected varieties have been increased into the F_3 stage.

While the provision of improved winter varieties of oats is desirable because of the serious limitations exhibited in the present-day varieties of this class, and as an indirect defence against Frit fly, there is still need for spring oats possessing as a defensive character high tillering capacity associated with rapid growth. With this objective in view, crosses have been made with such oats as Argentine and Gris de Houdan and a number of promising forms are now in the F_3 stage. The percentage of husk is a segregating character, and as Gris de Houdan is an oat with a low husk content, it is hoped to secure high qualitative values associated with the other features indicated.

Brassicae.—The attempts to produce polyploid forms from callus-buds have been continued. There seems no doubt that genuine callus-buds have been produced, though they do not come nearly so readily as in the classical case of the tomato. Owing, in addition, to losses in rooting the buds and in carrying them over the winter, few mature plants have been obtained and none of these were tetraploids. Work is therefore being directed largely to overcoming these technical difficulties.

In the experiments designed to produce new species by hybridisation, a quantity of F_2 and F_3 material, some tetraploid and some with fewer chromosomes, has been obtained from radish x *B. oleracea.* So far all suffer from reduced fertility, probably to be traced ultimately to the fact that in this material some pairing occurred between radish and cabbage chromosomes in F_1. The material will be continued in the hope of obtaining fertile segregates; in the meantime attention is being given to methods of circumventing reduced fertility.

A number of F_1 hybrids from other species flowered this year. Some of these have set a few seeds, and it seems highly probable that tetraploids have thereby been obtained from *B. chinensis* x radish, and it is possible that they may be obtained from turnip x radish and from *B. carinata* x *B. chinensis.* If this proves correct four new species will have been produced, and it may be possible to judge the lines along which future work must be directed to give results of economic value.

Peas.—The Institute's selection Maple I is being multiplied by the National Institute of Agricultural Botany in 1936, previous to being marketed. This pea has shown itself to be superior to any commercial variety in yielding capacity.

Meanwhile, the breeding of improved forms of Duns and Maples with shorter straw and earlier flowering is being continued. The most promising Duns are being obtained from crosses with the " green pea " varieties Glory and Unica; while an early, short-strawed Maple from Tibet, and New Zealand and Tasmanian forms, are being used for Maple improvement.

Some trouble has been caused to canners by the variety Lincoln Blue throwing " Dun rogues " and black hilum forms which spoil the samples from the canners' point of view. The origin of these forms has been studied during the last year, and the irregularity appears to be due to out-pollination with purple flowered Dun types. Rogueing while in flower should prevent the inclusion of these types in canning samples.

Genetic studies in peas have shown that linkage between the characters for early flowering, white flowers, tallness, and green seeds, almost precludes the use of certain crosses for the production of early flowering Maple peas.

Vernalisation.—Two years' experiments on the effect of low temperature pre-treatment of the germinating grain on the subsequent growth of cereals have shown that there may be a marked developmental stimulation. Winter varieties are much more responsive than spring varieties, and may show marked acceleration in earing, but the degree of stimulation depends on growing conditions. Observations on winter wheat varieties demonstrated that early tillering is stimulated, but the numbers of ears at harvest may be reduced. It is very doubtful if there is any practical application of this treatment to cereal growing in this country, but there may be some application for other crops.

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6. WELSH PLANT BREEDING STATION, ABERYSTWYTH

CEREALS.

Oats.

Spring oats for poor upland soils.—The trials relating to the first group of selections for poor upland soils have now been completed. One of these segregate strains has shown itself to be superior to the commercial variety Ceirch Llwyd now grown under these conditions in respect of grain quality and yield of straw. This new strain, arising from the cross *Avena strigosa* × *A. brevis,* designated Ceirch Llwyd Cwta, S.171, is also highly resistant to smut. Limited stocks of seed are now in hand and will be placed on the market through the agency of the Clarach Seed Growers' Association in the spring of 1936.

Spring oats for soils of medium fertility.—Two new varieties suitable for these conditions have reached the final stages of breeding and testing, and small stocks of pure seed are in hand. Of these varieties, S.174 is a cross between Record and Radnorshire Sprig, and is superior to the latter in grain yield and grain quality, and in resistance to lodging. The other variety, S.175, is from a cross between Victory and Black Bell III, possessing early ripening combined with a high yield of straw. The grain is of good size and quality.

Rod-row trials with a large number of new segregate strains were conducted in 1935. Future work will be concentrated upon the isolation of the best of these.

White-grained winter-hardy varieties of oats.—Largely on account of the relatively lower grain-producing capacity of commercial winter oat varieties advance in this section has been easier and more rapid. Two further stiff-strawed and winter-hardy varieties, S.172 and S.173, have been forwarded to the National Institute of Agricultural Botany for trials. Other strains superior to these in grain sample are under investigation.

Genetic investigations.—These relate mainly to a study of the "fatuoid" characters, namely, type of basal articulation, pubescence and awn development of the grain. Such characters have been studied in inter-hexaploid species and are now being investigated in inter-diploid and inter-tetraploid crosses.

Some F_1 pentaploid hybrids (tetraploid × hexaploid) were grown in 1935 and produced good vigorous plants. All, however, proved to be completely sterile when selfed; neither was any seed obtained by back-cross pollinations.

The inheritance of black and grey colour of the grain is also being studied.

Agronomic.—It has become apparent that the differential response of oat varieties to different levels of productivity is particularly important in connection with the conduct of variety trials (5). Thus varieties of Record type are superior in yield to varieties like Black Bell III and Radnorshire Sprig at productivity levels of 20 cwt. of grain per acre and upwards, but are superseded by the latter at lower levels of productiveness. These in turn are superseded by varieties like Ceirch Llwyd when the comparisons are made at the lowest cultivated levels of productivity.

Synonyms.—Two suspected synonyms of winter varieties of oats, and two of spring sown oats were under investigation in the season 1934-35.

HERBAGE PLANTS: BREEDING.

Grasses.

Cocksfoot.—The new broad-leaved pasture type has done exceedingly well in sward trials, consequently arrangements are now being made to hurry forward seed production with this strain, S.143.

Other grasses.—The present policy of the Station is to produce only a few strains of each grass studied, and to seek to improve these rather than produce new strains. Thus four strains of rye-grass are being bred: S.22, a quick growing but non-persistent strain of the Italian type; S.23, a slow-growing persistent spreading perennial type; and two intermediates, S.24 and S.101, of which the latter shows slower growth and greater persistence. All these strains are being improved, by selection and by crossing with new material.

Similarly three strains of Timothy are being bred and improved—S.50 a persistent pasture type, S.51 a quick-growing hay type, and S.48 an intermediate type. Suitable new material of this species is not so easy to obtain.

Strains of *Festuca rubra, F. ovina* and *Poa pratensis* (two strains) are also being maintained and improved.

It has been discovered that *Lolium perenne* and *L. temulentum* can be crossed: in certain respects a study of the progeny gives a clear indication of the genetical character of the former parent (3). Attempts have been made to produce hybrids between other speces of *Lolium,* with what success is not yet known.

Progress has been made with the genetical studies of *Lolium perenne.*

Meadow fescue, tall fescue and Yorkshire fog.—Breeding work with these species is being continued, and promising strains of the two latter have been obtained.

Genetical Work.—Routine genetical study of selected new material for crossing with established strains is always necessary to determine whether undesirable recessive characters are carried by the plants. This is done by self-fertilisation when possible; when it is not, out-crossing followed by inbreeding in the second generation is carried out.

Legumes.

Red clover.—Eight new strains, one early, one mid-early, three mid-late, two late and one wild x late derivative, were formed in 1935. The eight new strains produced in 1934 are being grown for seed and will be included in the 1937 trials. The eight strains produced in 1933 were included in four trials laid down at various centres in the spring of 1935. Two new strains which have been found to be superior to commercial varieties are now being released. Small quantities of seed of these two will be available for distribution in 1937.

Genetical investigations.—Considerable progress has been made in the study of a large number of both physiological and morphological characters. The linkage relationships of many of these characters are being investigated, and during the course of 1935 several new linkages were brought to light. The problem of heterosis in red clover is also receiving a great deal of attention (1, 11).

White clover.—In 1935 four new strains of white clover were produced. One of these is an improved wild white type, two are large leaved types and one is an intermediate form derived from crosses between wild white and Dutch white plants.

It is expected that small quantities of S.118, a large leaved strain which is intended to displace Dutch white clover for one year to three year leys will be available for distribution in 1936. This strain is being multiplied for seed under the auspices of the Essex Seed Growers' Association.

S.126, an improved wild white strain, is being propagated for seed by the Herefordshire Seed Growers' Association.

Lucerne.—Breeding work on lucerne and kidney vetch is being continued.

Two new strains of lucerne built up from the most promising lines are now being subjected to a field trial.

SEED PRODUCTION AND ISOLATION.

During 1935, 20 strains of grasses and clovers bred at the Station were being multiplied for seed on areas of one acre and upwards for each strain. These strains were grown for seed on farm lands outside the Station, and for the most part were established in the counties of Montgomery, Shropshire and Hereford. In addition, numerous strains were multiplied for seed in 1935 on areas of less than one acre, and either on Station land or on farms in the neighbourhood of the Station.

Approximately 33 acres of grasses were harvested for seed in 1935, and a further 50 acres were laid down for seed during the spring.

The Hereford Seed Growers' Association, through one of its members, harvested three acres of S.123, an extra-late flowering red clover, for seed during the summer of 1935, and the Essex Seed Growers' Association harvested three acres of S.118, an early type of white clover, for seed also in 1935.

INVESTIGATIONS.

Fungus Pests.—(*a*) Clover sickness, although only rarely reported in Wales, was very prevalent in Herefordshire and the adjacent counties in 1935. Preliminary experiments are in progress in the Bristol province in conjunction with the Station to test the susceptibility on infected land of various strains of red clover, including a number of bred strains. It is hoped that after the plots have been down two whole seasons that certain of the bred strains which have survived best will be grown for seed by transplanting the survivals to isolated spots.

(*b*) For the first time since the Station started gross multiplication of grass strains *Epichloe* appeared in 1935 with particular virulence on cocksfoot strains. The fact that the conditions which determine the appearance of this fungus pest are so little understood, and the devastating effect which it may have on the seed crops, indicate the need of investigations being set up with a view of finding measures of control. During the 1935 season it was observed that (i) first harvest year crops were to all appearances immune from attack, (ii) where cocksfoot crops were not subject to the severe frost in May no infected plants appeared, even when the crop was running into its sixth harvest year.

(*c*) During the seasons 1934 and 1935 a pedigree strain of timothy grown for seed in Montgomeryshire and in its fifth and sixth harvest year respectively has suffered from a disease or pest not yet identified by mycologists or entomologists. Approximately 15 to 20 per cent. of the inflorescences are destroyed just above the last node before the seeds begin to fill. This pest or pathological condition may prove to be a serious factor in attempting to grow successive crops of seed from a leafy and persistent type of timothy over a number of years.

Insect Pests:

Midges.—In conjunction with the entomologists of the Zoology Department, investigations have been continued in 1935 into the incidence of midges affecting the inflorescences of grasses cultivated for seed. This enquiry has produced useful results in that progress has been made in the understanding of the distribution and frequency of these midges in various areas. It has been observed, for example, that (i) the species affecting meadow foxtail are very rare or absent at 900 ft. elevation; (ii) perennial rye-grass is more subject to midge attack in the Severn Valley than on the coastal side of Plynlymon, and this fact has an important bearing on seed production, for the areas enjoying the best harvesting conditions appear to have conditions best suited to the multiplication of midges; (iii) the longer a stand is kept down for seed the more danger there is from midge attack.

Very little effective work has been done to find measures for controlling midges under field conditions.

Timothy fly (Amaurosoma *spp.*).—As far as Wales and the border counties are concerned the attacks were much less in 1935 than in former years, and generally the inflorescences affected were less than 1 per cent.

Apion *spp.*—*Apion* had a more devastating effect on red clover seed crops during 1935 in Wales and the border counties than for several years. The attacks on some red clover seed crops in Herefordshire and Shropshire were estimated to reduce the seed yield by nearly 50 per cent.

It was interesting to observe that of a considerable number of crops examined only two red clover crops kept for seed contained quite negligible numbers of *Apion* larvae. Both these crops stood at over 900 ft. elevation in Montgomeryshire.

General.

(*a*) Work on seed production of pasture perennial rye-grass. The evidence gathered from this work in progress suggests that the strain studied (S.23) may be grown broadcast under a cover crop for seed without incurring a substantial diminution of seed yield as compared with drill culture. Evidence is being collected also on the effect of grazing on seed yield; effect of manuring; effect of cutting back in autumn; first compared with second seed crops.

(*b*) The work on manuring creeping types of grasses for seed is being continued, and in addition a study of the effect of autumn grazing on such grasses was begun. Difficulties are experienced in getting satisfactory crops of seed from red fescue after the first year, especially in districts with relatively high rainfall, and it may prove that autumn manuring, together with grazing and cultivating, will in combination prove successful.

(*c*) Work begun in previous years to study the effect of management on yields of red clover seed is being continued.

(*d*) Studies on distance isolation of red clover grown for seed were completed and published in 1935 (1). The results indicate minimum distances at which crops grown for seed should be isolated from similar crops. Experiments are being laid down to obtain information on the effect of distance isolation on the purity of a strain of white clover without leaf marks.

Small plots of perennial rye-grass laid down with a view to obtaining further information on the effect of distance isolation on purity are being continued.

(*e*) Work on the effect of density of planting on seed production in cocksfoot was completed and published in 1935 (2). It was shown that individual plants produced the greatest quantity of seed when widely spaced, but that the yield of seed per unit area did not increase when spacing was increased beyond twelve inches between the plants.

(*f*) The influence of (i) nurse crops, (ii) manuring and (iii) autumn grazing on cocksfoot grown in drills for seed was studied further. Heavy crops of oats as nurse have a very depressing effect on the first seed crop of cocksfoot.

(*g*) A trial was laid down to test the relative seed producing capacities of bred strains of (i) perennial rye-grass, (ii) cocksfoot, (iii) timothy, (iv) red clover and (v) white clover. These strains are being released to the seed trade.

(*h*) Studies were continued on the moisture content of seed with a view to making calibration charts for different types of seed to serve in conjunction with the Davies Moisture Tester, and also on methods of storing stock seed over a number of years.

(*i*) The possibilities of utilising a seed stripper for gathering grass and clover seed were tested. No definite conclusions were arrived at in relation to the harvesting of wild white clover for seed, but it seemed that where much foliage existed in the crop the machine could not improve on the ordinary mower, particularly when no artificial means of drying the crop collected by the stripper was available. This machine may be exceedingly useful for such seed crops as *Agrostis, Poa pratensis* and *P. trivialis,* and possibly rye-grass after cattle grazing.

(*j*) Successful attempts were made to control loose smut of wheat by the hot water method, which gave complete control.

SEED GROWERS' ASSOCIATIONS.

(a) *Clarach Valley Seed Growers' Association.*—As in the past, this Association is concerned with growing and marketing seed oats derived from types bred by the Station for soils of low fertility.

It was supplied in the spring of 1935 with stock seed of a new oat, S.171, derived from a cross between *A. strigosa* and *A. brevis* expected to replace the ordinary *A. strigosa* on account of its larger bulk of fodder and better quality grain. A strong demand for the crop of this variety has already been made.

(b) *Essex Seed Growers' Association.*—This Association is now growing three strains of grasses bred by the Station; cocksfoot S.26, perennial rye-grass S.23 and timothy S.51, and in addition one strain of white clover, S.118, is being propagated for seed.

(c) *Hereford Seed Growers' Association.*—This Association decided that its members should in the first instance grow pedigree grass seed on contract for the Station in order that growers might become acquainted with the technique of seed production under the direction of the Station's officers. It is the intention of the Association to appoint an agent during 1936 to clean, grade, store and market certified crops of pedigree grass and clover strains grown by its members.

(d) *Hay to Talgarth Seed Growers' Association.*—Steps are being taken by farmers in the Hay to Talgarth district of Breconshire to establish a Seed Growers' Association. There is every likelihood that when the Association is established it will undertake to grow and market seed of the newer white varieties of winter oats intended for hill districts or second-class soils.

GENERAL GRASSLAND RESEARCHES.

Trials with sheep.—The grazing trial to test, by live weight increase of sheep, the relative merits of an indigenous mixture and a farmer's ordinary mixture, together with a comparison of indigenous rye-grass and indigenous cocksfoot with and without wild white clover has now completed its fourth year. As in previous years, the " indigenous " mixture has again given better results than the " farmer's " mixture. The *with* wild white clover plots have also given far better increments than the *without* wild white clover plots, in spite of the fact that white clover had established itself to a certain extent on some of these latter plots. Unlike previous years, the best performance was given by the plot consisting of a mixture of cocksfoot, rye-grass and wild white clover, and the rye-grass-white clover plot, which had done best in each of the three previous years, came a good second (7).

The trial to compare the feeding value of "commercial" rye-grass with "indigenous" rye-grass has completed its second year. In the first half of 1935 the two were running level, but the indigenous gave a better increase during the second half of the season.

The trials to ascertain the effect of different methods of management on swards were continued. It appears that close grazing on wet areas is favourable to the formation of a dense sward composed of small tillered grasses and clover, while under-grazing, and in particular no grazing at all, favours a more open sward with fewer but much bigger plants.

Miscellaneous investigations.—An extensive survey of the buried seed content of innumerable types of sward has now been completed. Experiments on the dry-matter content of herbage plants under grazing and cutting conditions have revealed a considerable difference in the dry-matter content according to the system of cutting adopted, together with a marked seasonal variation, and marked variation between different species and strains. Of the more productive grasses timothy had the highest dry-matter content. The investigation is being continued and expanded also to include miscellaneous herbs (8).

Investigations of the soil germination and establishment of commercial strains and the pedigree strains have been concluded. There is a wide difference in establishment in the autumn of the seeding year, but this levels out during the second harvest year (9).

The effect of grazing upon the composition of hill swards with and without fertilisers has been further investigated. Controlled grazing with the addition of fertilisers resulted in swards differing in botanical composition from those produced under free grazing conditions with the use of the same manures (10).

Titles of papers issued during the year.

1. Evans, Gwilym, and Williams, R. D.: The efficiency of spatial isolation in maintaining the purity of red clover. *Welsh J. Agric.*, **11,** 164-171, 1935.
2. Evans, Gwilym: Seed production in cocksfoot: Density of spacing in relation to yield. *Ibid.*, **11,** 158-164, 1935.
3. Jenkin, T. J.: Interspecific and intergeneric hybrids in herbage grasses. II. *Lolium perenne* × *L. temulentum*. *J. Genet.*, **31,** No. 3, 379-411, 1935.
4. ————: Arbrofion Cymreig ar gynyrchu mathau newydd o weiriau a meillion. *Y Cymro*, 9th March, 1935.
5. Jones, E. T.: Observations on yield trials and varieties of spring sown oats in relation to different levels of productivity in Wales. *Ann. Appl. Biol.*, **22,** 208-224, 1935.
6. ————: Spring sown oats in Wales. *J. Min. Agric.*, **41,** 1182-1186, 1935.

7. Jones, Ll. I.: Pasture management and its effect on the sward. *Welsh J. Agric.*, **11**, 96-120, 1935.
8. Milton, W. E. J.: The dry-matter content of certain grass and clover species. *Emp. J. Exp. Agric.*, **3**, 197-202, 1935.
9. ————: The soil establishment of pedigree and commercial strains of certain grasses. *Welsh J. Agric.*, **11**, 171-181, 1935.
10. ————: A comparison of the composition of hill swards under controlled and free grazing conditions. *Ibid.*, **11**, 126-132, 1935.
11. Williams, R. D.: Genetics of flower colour in *Trifolium pratense* L. I. Basic white colour (Factor C). *J. Genet.*, **31**, No. 3, 431-450, 1935.

7. SCOTTISH SOCIETY FOR RESEARCH IN PLANT BREEDING, EDINBURGH

CEREALS AND BEANS.

Oats.—Several groups of unfixed hybrids of different generations ranging from the first to the seventh, were grown as spaced plants for observation and selection. Further studies were made on a group of hybrid third-generation plants (Victory × Orion), to obtain additional data on the inheritance of grey grain. As in another cross (Record × Orion) a few of the second-generation plants having white grain gave rise to plants bearing distinctly grey grain. Since the first- and second-generation plants were protected from cross-pollination the origin of these apparently aberrant types requires more investigation.

The studies of the inheritance of striped leaves in oats (2) have been brought to a conclusion. The inheritance of this character is purely maternal.

A series of Elder × Orion fourth-generation hybrids was grown, and it contained some early-ripening plants having the Elder type of upstanding straw. Unfortunately, this was the only series which suffered extensive damage by eelworm. A small proportion of the plants was not badly affected and of these, a few have been retained for future experimentation.

In the dry summers of 1934 and 1935 " blind " or barren spikelets were prevalent in many oat crops, some varieties being more severely affected than others. Possibly drought promotes the development of this defect. Differences in the amounts of barren spikelets were also noted among the hybrid progenies, a few selections being almost free from this trouble while others grown alongside were markedly affected. Those that appeared to be resistant to the trouble have been retained for further observation.

Although huskless oat varieties have been tried in this country from time to time none, so far, has been a success. The

Canadian huskless varieties Laurel and Liberty have been under observation at the Station in recent years, but they do not seem well adapted to Scottish conditions. They are early-ripening, but both varieties give too low yields of grain compared with those obtained from most standard varieties. It is believed that naked oat grains are very suitable for poultry feeding and efforts are being made to see whether more productive huskless-oat varieties can be evolved for Scottish conditions.

Twenty-one fixed hybrid varieties and nine named varieties were included in yield trial plots laid out in the randomised manner. While the drought during part of the summer was severe and caused the plants to ripen rapidly, the yields of grain were higher on the average than they were in 1934 and better comparisons could therefore be made. There was no lodging among the cereal crops, and very little difference among varieties was revealed as regards resistance to lodging. Several selections gave high yields of attractive grain.

A few new varieties of oats received from abroad were added to the collection of named varieties grown for observation. Some of them are reputed to be resistant to certain diseases and they may be useful as parental material.

Barley.—The selections of Common Scotch Barley chosen in 1934 were lined in 1935. The trial plot showed that this variety of barley contained various forms, and representatives of these will be included in future trials at the Station.

An awnless six-rowed barley, which has comparatively short straw, has been successsfully crossed with some of the cultivated varieties of barley. The progenies of the crosses will, it is expected, provide interesting material for study and selection.

Beans.—The selections taken in 1934 from several varieties of field beans were lined, and further comparisons and selections will be made with a view to finding whether any improved types can be secured by selection from commercial varieties.

Samples of six varieties of Soya Beans were sown in small observation plots. The seed before being sown was inoculated with a culture of the appropriate nodule-forming organism. Two varieties grew more vigorously than the others but all produced light crops. The wet weather in September and October was not favourable to the development of these beans, and little growth was made after the middle of September. Very few nodules appeared on the plants grown in the field, but nodules were present in greater numbers on the plants grown from inoculated seed sown in pots. Plants of the same varieties grown in pots from non-inoculated seed bore no root nodules. Seed was obtained from all varieties, and trials may again be made in 1936.

POTATOES.

The work with wild tuber-bearing solanums has been continued and a proportion of the seedlings grown were obtained by interspecific hybridisation or by back-crossing certain hybrids previously secured. By further breeding and selection an attempt will be made to produce new forms of commercial value.

The investigations designed to study the effect of repeated self-fertilisation of varieties and the results of intercrossing selfed lines were continued and several progenies were grown to provide material for this work.

The study of the mode of inheritance of resistance to wart disease was brought to a conclusion, and the results published (3). The inheritance of resistance, which has a physiological basis was explained on the hypothesis of three factors having different quantitative effects, which produce different degrees of resistance in potato varieties.

Several of the Society's most promising seedlings were included in the Registration Trials of the Department of Agriculture for Scotland in 1935 and also in the Wart Disease Immunity Trials carried out by the National Institute of Agricultural Botany at Ormskirk. In each of the trials certain varieties have been recommended for further trial in 1936.

HERBAGE PLANTS.

The breeding of strains of cocksfoot, perennial rye-grass and of both diploid and hexaploid timothy has been continued. One strain of diploid timothy and one of cocksfoot have now reached the stage of seed multiplication on a commercial scale.

This year the initial multiplication plot at the Plant Breeding Station contained a race of hexaploid timothy and a pasture race of perennial rye-grass.

Some years ago fertile hybrids were obtained from crosses between diploid timothy and tetraploid alpine timothy. Selection of types from this material has been continued and last summer selfed seed was saved from many of the most promising types.

Crosses between self-sterile plants of Scottish cocksfoot were successfully made in the greenhouse during the summer, and the populations which will be raised from this seed will provide useful material for future selection.

No definite results regarding the behaviour of new herbage strains in the field trials laid down during the last two years have yet been obtained. The diploid timothy has proved its usefulness as a bottom grass in a mixture sown three years ago. The new strain of cocksfoot included in the same mixture also proved satisfactory. While the cocksfoot developed rapidly providing herbage during the first grazing season, the timothy on the other hand established slowly and did not appreciably add to the herbage until the second grazing season.

The investigations on sea plantain relating to the ecotype concept and its practical application have progressed a stage further. The conclusions so far reached have an important bearing on many agricultural problems, including that of supplying the farmer with information concerning new strains of herbage plants.

SWEDES AND TURNIPS.

The investigations of the possibilities of securing pure breeding strains of swedes by continued selection and by self-fertilisation under artificial isolation were continued. Pedigree lines were maintained and some of these are now in the seventh generation of inbreeding. New selections were made chiefly from the segregating generations of artificial inter-varietal crosses.

The manner of inheritance of various characters such as colour of flesh, skin and flower, type of foliage, shape of bulb, disposition to bolt and resistance to disease were further studied.

Investigations concerning hereditary differences in composition, as indicated by dry-matter percentage and bulb weight were mainly confined to trials of F_3 lines. About 50 strains had been obtained from a single cross between a hardy green-top and an early purple-top swede. Plots of these third-generation strains had been tested in bulk in the trials of 1933. In the autumn of 1934 an examination of plant variability was carried out on the same strain. From measured strips containing approximately equal numbers of plants series of bulbs of each strain were weighed and tested for dry-matter percentage individually.

Pedigree lines were sown out in duplicate plots with suitable controls and observations made at intervals. Trials were prepared for the purpose of determining yields at the end of the season in 1935. About 200 selected plants were self-fertilised under controlled conditions and some artificial hybridisations were made. Quantities of seed sufficient for future experiments were obtained.

Preliminary observations were made on small plots of Marrow-Stem and Thousand Head Kale to ascertain the possibility of securing improved strains by selection within varieties.

The early part of the season was remarkably dry and this retarded growth. Towards the end of the season attacks by mildew and aphids caused considerable damage in the trial plots.

POTATOES—VIRUS DISEASE INVESTIGATIONS.

The chief investigations have been concerned with:—the classification of potato varieties according to their various reactions to potato viruses; problems connected with the inheritance to these reactions; and field trials designed for the purpose of obtaining data on the comparative susceptibility of named varieties and seedlings to natural infection with the Y virus and the virus of leaf-roll.

In the classificatory work 155 named varieties and many seedlings at an advanced stage of development have been used. A study of the reactions of these varieties and seedlings towards virus X has enabled three classes to be distinguished. The first class contains 17 varieties which respond to infection either as perfect or as almost perfect symptomless carriers of the X virus. The second class contains 66 varieties in which the presence of the virus is indicated by "mosaic" symptoms. The third class contains 30 varieties in which infection results in necrotic symptoms of either a fully lethal or a semi-lethal nature. The remaining 42 varieties have not yet been obtained in a condition free from either virus A or virus Y and therefore it has not been possible to determine the effect of virus X alone upon these.

The reactions of all the above varieties to the Y virus have proved to be more complex than the reactions to the X virus. Tentatively, 12 classes of reaction have been established. These classes may be brought together under two groups, of which the first group of 25 varieties includes those in which disease symptoms are not very pronounced and the plant vigour is not affected to a very large degree. The second group of 124 varieties includes all those varieties which show severe symptoms of infection and definite reduction in vigour. It was not possible to determine the reaction of six varieties owing to the presence of virus complexes, such as A + X and X + Y already present within them.

The inheritance of reaction to virus X has been studied by stem grafting in seven progenies comprising 324 plants. This investigation has indicated that reaction is an inherited character probably dependent upon two or more genetical factors.

Field work has been conducted with material in three groups, each of which was reasonably well isolated. The leaf-roll investigation included 151 named varieties and approximately 1,500 seedlings, together with leaf-rolled plants acting as centres of infection. In this particular investigation, infection as judged by the appearance of primary symptoms was not observable until the end of September and therefore no definite results are yet available.

A similar trial with 151 varieties and 750 seedlings, together with Y infected plants as disease centres, has, however, yielded interesting data, particularly when considered together with observational data of a semi-quantitative nature collected throughout the season, with regard to the aphis population of the plots. Although a slight passage of infection was observed early in the season when aphids, particularly *Myzus persicae* were present but only in small numbers, the bulk of infection did not take place until the beginning of September. This maximum period of spread of infection has been correlated with the appearance of winged aphids and a rapid increase in the aphis population during the latter part of August. The amount of new infection during the whole season, basing the estimate upon observed disease symptoms alone, was at least 58 per cent. of the total number of plants in the field.

Additional investigations have included field studies upon the transmission of virus A and virus X, the two constituents of the disease crinkle; further observations upon the reaction in the field of plants infected in the greenhouse in 1934; and a continuation of the study of the effect of virus diseases on vigour, flowering, and seed production.

The sub-station at Ainville has been used mainly for supplying healthy material for the virus work in progress at Craigs House and all newly " imported " material is first grown at Ainville and examined by direct observation and by inter-varietal grafts for the presence of viruses. In the past year 146 new stocks have been thus examined, of which 75 were found to be infected with one or more of the viruses X, Y and A, whilst the remaining 71 were apparently free from these viruses.

From seed obtained in 1934, 1,100 seedlings in seventeen progenies have been raised for inclusion in the susceptibility trials at Craigs House in 1936.

For the purpose of pursuing genetical research into the hereditary nature of resistance and susceptibility to virus diseases, inbreeding and hybridisation on lines indicated in a previous report, have been carried one stage further. The results of the current season's investigations have been helpful in indicating certain lines that may profitably be pursued.

Attention has also been devoted to the study of abnormal and semi-abnormal plants. The material used in this investigation was raised entirely from tubers of second and third year abnormal seedlings and useful descriptive data have been obtained.

Titles of papers issued during the year.

1. Robb, William: Society's Annual Report for the year ended 31st March, 1935.
2. ———: Inheritance in oats, with special reference to striped leaves. *Proc. World's Grain Exhib. and Conf.*, Regina, 1933. **2**, 84-88, 1935.

3. Black, William: Studies on the inheritance of resistance to wart disease (*Synchytrium endobioticum* (Schilb.) Perc.) in potatoes. *J. Genet.*, **30**, No. 1, 127-146, 1935.
4. Gregor, J. W., and Horne, F. R.: Growth forms: genecology and its agricultural significance. *Agric. Prog.*, **12**, 89-98, 1935.
5. Snodgrass, C. P.: The physical environment of Scottish agriculture in relation to crop improvement problems. *Ann. Appl. Biol.*, **22**, No. 3, 443-464, 1935.

8. PLANT BREEDING DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

Oats.—Selection amongst various hybrid progenies has now isolated a number of promising types whose characteristics appear to be fixed, and preliminary tests are in progress which should determine which of them will be propagated to bulk.

The cross Argentine × Grey Winter has yielded a large number of good white grained winter hardy types—many more than either Victory × Grey Winter or Ligowo × Grey Winter.

For poor cultural conditions some of the selections from crosses between Potato and Tyrone Tawny types seem very likely to become useful additions to the very small list of varieties available. These include both grey and white types and, surprisingly, some with a prostrate habit in the early stages of growth.

Flax.—The acreage under flax continues to expand more rapidly than do the available seed supplies of the best varieties, thereby creating a problem of much greater importance than is the further improvement of such varieties. Nevertheless it may be mentioned that a new selection of Stormont Gossamer, now under test, has given excellent results so far.

9. NATIONAL INSTITUTE OF AGRICULTURAL BOTANY, CAMBRIDGE

Crop Improvement Branch.

Trial centres.—The sub-station at Good Easter, near Chelmsford, was closed down in the autumn of 1934 and in co-operation with the Department of Agriculture, Leeds University, a sub-station for crop variety testing has been established at Askham Bryan, near York. Although most useful results have been obtained from trials at Good Easter, it is felt that the setting up of a Yorkshire centre will provide the Institute with a basis for recommendations under more diverse conditions than hitherto.

A number of trials have been carried out in co-operation with other organizations, and a larger number of spring oat trials were arranged by county education authorities than in 1934.

Varieties tested in field trials.—Winter wheat: 13 varieties under normal, and 5 varieties under high farming conditions. Winter oats: 3 varieties (at Askham Bryan only). Spring wheat: 4 varieties. Spring barley: 8 varieties. Spring oats: 6 varieties. Sugar beet: 12 strains. Lucerne: 6 strains. Field peas: 14 strains. Sainfoin: 6 strains. Marrow-stemmed kale: 5 strains. Thousand-headed kale: 2 strains.

Observation plots.—Many strains of the crops grown in field trials were grown in preliminary observation plots. In addition there were plots of winter barley, mangolds, swedes, rape kale, clovers, maize, green peas, soya beans, kidney beans and kidney vetch. Altogether over 250 varieties of the principal farm crops were represented in this way.

Seed growing.—Seven acres of the wheat grown in trials as W.70A, and subsequently named Holdfast, and produced by the Cambridge Plant Breeding Institute were grown under contract. The produce was cleaned at the Institute's granary and was put on the market through the seed trade.

Twenty-five acres of a pure stock of Wilhelmina were also grown near Cambridge and 110 quarters of seed were marketed.

In order to produce seed for sale in the autumn of 1936, three acres of a pure stock of Little Joss were sown under contract and the produce was resown in the autumn of 1935.

Similarly, three acres of the pea grown in trials as Maple I were sown at Cambridge for further multiplication in 1936. This is a selected Maple pea and has given outstandingly high yields as compared with a commercial stock. It is dark in colour and has a black hilum. It is round in shape and does not shrivel on storage as much as is usually the case with English Maples. During the past two racing seasons it has been used with success in feeding pigeons.

Seed for the 1935-36 series of county winter oat trials was grown near Cambridge. Four acres were sown with each of the varieties Grey Winter and Resistance and the Welsh Plant Breeding Station's productions S.81 and S.82, and satisfactory yields were obtained from Resistance and S.81. That of S.82 was not high, while Grey Winter produced very much less grain than the other varieties, and in fact the yield was insufficient to meet the whole of the demand for seed.

OFFICIAL SEED TESTING STATION.

During the twelve months ending 31st July 1935 the Station tested 28,327 samples from outside sources. This is compared with 27,077 samples in the season 1933-34, and is the highest number ever tested during the twelve-month period. In addition, 2,175 samples were dealt with in the course of various investigations.

It is of interest that, as in the previous season, the Station received over 1,000 samples of grass seeds not covered by the Seeds Regulations. In the main these consisted of species of *Poa, Festuca* and *Agrostis,* i.e. turf production grasses.

Another feature with regard to grasses which is worthy of note lies in the fact that no fewer than 10 per cent. of the samples of Timothy received during 1934-35 were found to contain Dodder. All of these were of European origin, the number of such samples being abnormally high owing to the shortness of the American crop. The latter is usually free from Dodder.

Each season a certain number of samples of celery seed are submitted to the Station for examination for the presence of seed borne diseases, and in recent years an increasing interest has been displayed by the senders of such samples in the incidence of *Phoma apiicola* (Phoma root-rot) as well as of *Septoria Apii* (celery leaf-spot). An examination for both diseases is now made of all samples submitted for special examination.

The Wild White Clover Certification Scheme, organized by the Ministry of Agriculture in co-operation with the National Farmers' Union, with a view to encouraging and assisting the production and marketing of genuine home-produced wild white clover seed, has now been in operation for six seasons, and during this period the Station has dealt with a total of 890 " head " samples collected from pastures inspected under the scheme, including 37 received in 1934 and 15 in 1935. These " head " samples are collected in the summer of each year and upon their receipt at the Station, the seed is rubbed out, scarified and sown in row plots in the early autumn, the resulting plots being examined in the following summer by a committee set up for the purpose.

POTATO TESTING STATION.

Official immunity trials.—This year there were 36 entries for the first year's trials and 28 for the second, whilst 17 came from the official stations of Northern Ireland and Scotland under the scheme of inter-departmental checking.

Three hundred and seventy-five entries were received for the seedling trials and were tested in the field. Six hundred and ninety-two tubers were tested in the glasshouse, of which only 2·3 per cent. rotted. These tubers represented 79 varieties sent for the immunity trials and 219 varieties sent for the susceptibility trials, two established immunes and one special test. None of the 375 entries for the seedling trials was tested in the glasshouse. The total number of seedlings tested was 676.

One hundred and eleven specimens from the inoculation test were sent to Rothamsted Experimental Station. As in previous years none of the varieties which bore casual winter sporangia indoors showed any sign of infection in the field.

Of the varieties entered for the immunity trials, 5 (or 7 per cent.) proved to be synonymous with existing varieties. While this figure is higher than in the past few years, it is nevertheless low.

Lord Derby Gold Medal trials.—These trials are laid out with the object of determining which, if any, of the new varieties of potatoes certified by the Ministry of Agriculture as being immune from wart disease give evidence when grown in Lancashire of possessing outstanding merit.

This year a Gold Medal was awarded to the early maincrop variety Gladstone. The control varieties used in the trial were King Edward and Majestic. The varieties Gladstone and King Edward produced much the same yields of ware, although both were significantly outyielded by Majestic. In the opinion of the Gold Medal Committee the sample of Gladstone ware was more attractive than that of King Edward, the tubers being more consistent in shape and size. Second growth was entirely absent. The tubers of Gladstone were oval to kidney in shape, the skin white with red blotches, the colouring somewhat similar to that of King Edward and the eyes shallow.

A cooking test showed that the cooking qualities of Gladstone were outstanding, being equal to King Edward when fried and better when steamed, thus confirming numerous private tests, and the Committee unanimously decided to award a Gold Medal to this variety.

Three other varieties were entered for trial, but failed to receive awards; two of them, however, will again be tested in 1936.

Seed production.—A scheme commenced in 1934, whereby three Lancashire growers were provided with a few hundredweights each of stock seed of the new early varieties Arran Pilot and Arran Crest in order that growing seed in isolation might be tried out commercially, has proceeded successfully. This year a number of acres were planted with the produce of this seed, approximately eight acres of Arran Pilot and four acres of Arran Crest. The growing crops were rigorously inspected for the presence of virus diseases and the whole of the Arran Pilot acreage remained apparently free from virus infection. Heavy crops were obtained and, as a result, a number of the growers are responding to the scheme with enthusiasm, and are extending the scheme to other varieties.

Other trials.—The variety Bintje was tested in a trial at Cambridge and in observation plots at Kirton in 1934, and the trial was repeated in 1935. As far as Bintje was concerned the results were much the same as in 1934, a Dutch stock giving a similar yield to King Edward. A Lincolnshire grown stock was also included and was found to produce a proportion of virus-infected plants, while the yield was rather lower than that of the Dutch stock.

Doon Star made a poor showing. Its yield was lower than that of any other variety and the tubers were small in size.

Cooking quality.—Trials of King Edward and Majestic which were replicated eight times were planted on the Dunbar red soil, the oolitic limestone of Lincolnshire, black fen soil, and at Ormskirk. Properly replicated samples were also obtained from the Kirton trial. Samples of ware from six of the replications at each centre were sent to Cambridge and will in due course be despatched for testing.

Potato root eelworm.—The problem of potato eelworm continued to be investigated. In view of the beneficial effects of heavy dressings of sulphate of potash reported from other sources, a simple trial was laid down in 1935 in collaboration with the authorities of Manchester University. A piece of land known to be highly infested with eelworm cysts was split up into four equal squares. The whole of the plot received a heavy dressing of farmyard manure, together with the normal dressing of artificials applied at the station. Ten days after planting two of the squares received a dressing of sulphate of potash at the rate of 15 cwt. per acre, the remaining two squares serving as controls. At no time during the growth of the plants in this trial was any difference observed in the vigour and appearance of the foliage in the treated and control plots. The treatment was, therefore, not efficacious at Ormskirk.

Titles of papers issued during the year.

1. Fifteenth Annual Report.
2. Sixteenth Annual Report.
3. *J.N.I.A.B.*, **3**, No. 4, 1934.
    - (*a*) Parker W. H.: The methods employed in variety trials by the National Institute of Agricultural Botany.
    - (*b*) Armstrong, S. F., and Brandreth, B.: Trials of Spratt-Archer and Plumage-Archer 1924 barleys (under normal and intensive conditions of manuring).
    - (*c*) Parker, W. H., and Tozer, M. G.: County spring oat trials, 1932.
    - (*d*) Thomson, E. G.: Trials of spring sown oats, 1929-1931.
    - (*e*) Humphries, Sir Albert, Humphries, S., and Read, L. H.: The quality for breadmaking purposes of wheats harvested in 1933.
    - (*f*) Salaman, R. N.: Report of the Potato Synonym Committee, 1933.
    - (*g*) Bryan, H., and Brandreth, B.: The Lord Derby Gold Medal potato trials, 1934.
    - (*h*) Parker, W. H., and Brandreth, B.: Potato variety trials, 1933-34.

(*i*) Parker, W. H., Salaman, R. N., and Brandreth, B.: Cooking quality in potatoes.
(*j*) Eastham, A.: Fifteenth annual report of the O.S.T.S. for England and Wales (1931-32).
(*k*) ———: Sixteenth annual report of the O.S.T.S. for England and Wales (1932-33).
(*l*) Russell, Sir John: The National Institute of Agricultural Botany and the changing agricultural situation. Thirteenth Annual General Meeting of the Fellows of the Institute.

4. *Ibid.*, **4**, No. 1, 1935.
(*a*) Brandreth, B.: County spring oat trials, 1931-33.
(*b*) ———: County spring oat trials, 1934.
(*c*) Thompson, E. G.: Trials of winter oats, 1931-34.
(*d*) ———: Trials of field peas, 1930-33.
(*e*) Salaman, R. N.: Report of the Potato Synonym Committee, 1934.
(*f*) Report of the Cereal Synonym Committee, 1934 and 1935.
(*g*) Bryan, H.: The Lord Derby Gold Medal potato trials, 1935.
(*h*) Brandreth, B.: Potato variety trials, 1934-35.
(*i*) Eastham, A.: Seventeenth annual report of the O.S.T.S. for England and Wales (1933-34).
(*j*) Gavin, W.: The Institute and the Seed Trade. Fourteenth Annual General Meeting of the Fellows of the Institute.

FARMERS' LEAFLETS.

5. No. 7. Choice of seed.
6. No. 2. Varieties of cereals for spring sowing. (Revised edition January, 1935.)
7. No. 1. Varieties of cereals for autumn sowing. (Revised edition February, 1935.)
8. No. 3. Varieties of potatoes. (Revised edition March, 1935.)
9. No. 5. Strains of sugar beet. (Revised edition November, 1935.)
10. Potato synonyms.
11. Cereal synonyms.

10. PLANT REGISTRATION STATION, DEPARTMENT OF AGRICULTURE FOR SCOTLAND

POTATOES.

Registration scheme.—In 1935 there were under test with a view to their registration as improved varieties immune from Wart Disease:—31 in their first year of test, 13 in their second year of test, and 7 in their third year of test.

In December, 1934, the Department, on the recommendation of the Standing Committee of Management of the Station, agreed to the registration of the following varieties:—Doon Early, Gladstone, The Alness, and Redskin.

Wart disease immunity tests.—Field tests for immunity from wart disease were discontinued in 1935.

The laboratory test, supplemented by tests in pots in the open and by check tests of samples in the field to confirm identity and trueness of stock, is now regarded as an effective method of determining susceptibility.

In 1935 the tests comprised:—

> Single-tuber samples, 196 (46 susceptible); Four-tuber samples, 24 (4 susceptible); Inter-departmental Checks (10-tuber samples), 42 (none susceptible); Registration Tests, 32 (7 susceptible).

Virus disease scheme.—The scheme for building up healthy stocks of varieties of the potato was discontinued in 1935. The special facilities provided at the Station for virus disease experiment are now entirely used for the purpose of providing material for the information of inspectors engaged in the Department's scheme of certification of field crops and for the purpose of solving any problems arising therefrom.

Skin spot investigation.—The experiments were continued in 1935.

OATS.

Four varieties were under test for the first time in 1935.

11. CROP (AND ANIMAL HUSBANDRY) DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

Grassland improvement.—The experiment commenced in 1929 to investigate some of the problems concerned in the management of grassland has been discontinued owing to the scarcity of water in the field. During 1933 and 1934 the water shortage became acute and necessitated the removal of the stock from the plots during the flush of the grass. The grazing figures obtained have not, therefore, indicated the maximum stock carrying capacity of the plots, especially plots 4 and 5, which were ploughed up and seeded down in 1930, and which, by appearance, were producing far more nutritious herbage than the permanent grass plots 1, 2 and 3.

Some very useful general observations have, however, been obtained from the experiment. The grass on plots 1, 4 and 5, which received each spring a dressing of nitrogen, made a much better growth early in the season than plots 2 and 3, which received no manure since 1931. Plot 3, which received phosphates only, was distinctly inferior to plot 1 (complete dressing) and 2 (phosphates and potash) and this inferiority was apparent in the grazing figures obtained. It was also very noticeable each season that the grazing stock showed a marked preference for plots 4 and 5, the re-seeded plots, which were thus much superior to the other plots in the very important aspect of palatability.

It would appear from the appearance of the plots after a period of four years that quicker and more beneficial results have been obtained by ploughing up and re-seeding immediately, followed by suitable manuring, than by surface cultivation and manuring.

Barley variety tests.—The experiment to test the suitability of different varieties of barley, for feeding purposes, under average soil conditions in Northern Ireland has been continued. Very satisfactory yields were obtained in 1934 from the varieties under test: Spratt Archer, Golden Archer and Old Common. These were again sown in 1935 with the addition of the variety Abed Kenia, which is short in the straw and less liable to lodge on softer peaty soil than the longer strawed varieties.

Marrow stem kale.—An experiment was laid down with this crop to compare different widths of thinning, with and without a nitrogenous top-dressing. The plots will be cut for feeding at different periods during the winter.

Cost accounts.—The cost accounts have been continued during the year at the farm of the Agricultural Research Institute at Hillsborough. Full records of costs relative to farming operations, reconstruction of existing buildings and erection of new buildings are now available over a period of seven consecutive years.

12. SEED TESTING (AND PLANT DISEASE) DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

SEEDS.

Ultra-violet light tests.—As noted in last report this test is now in routine use for (*a*) determining the proportion of true perennial rye-grass in samples described as " Italian rye-grass " and (*b*) distinguishing certain strains of perennial rye-grass. As regards (*a*) a number of samples have been examined for merchants with satisfactory results. Relative to (*b*) the test has, in practice, proved particularly useful for distinguishing home strains from certain inferior overseas types which were imported in quantity during the season under review.

The relationship between the proportions of awnless seeds and those of perennial rye-grass in British commercial samples of so called " Italian rye-grass " was further investigated (1). It was found that in the material examined the percentage of awnless seeds was positively correlated with the percentage of true perennial rye-grass present. Only one-quarter of the lots contained less than 10 per cent. true perennial rye-grass. It was suggested that the sale of mixed rye-grasses as pure Italian will continue so long as routine seed analysis does not attempt to separate perennial from Italian. Awned seeds in commercial perennial samples can be classed as Italian rye-grass, but awnless seeds of the latter are not at present classed as perennial rye-grass, since the absence of an awn may theoretically be due to mechanical injury. In practice, however, as this investigation shows, the proportion of awns removed in threshing remains approximately constant, and where the awnless seed content rises beyond 25 per cent. (and this figure allows a generous error margin) the increase is brought about by the presence of perennial rye-grass. As an initial step, to cover flagrant cases, the desirability of reporting the proportion of awnless seeds in Italian samples when over 40 per cent. is emphasised.

Indigenous strains of grasses.

(i) *Strains already purchasable.*—The plots sown in 1932 in collaboration with County Instructors in Agriculture for comparison, for pasture purposes, of indigenous and commercial strains of rye-grass having been under observation for three growing seasons it is now possible to formulate tentative conclusions with regard to the particular strain used. The main points emerging from a general view of results at 15 centres distributed over Northern Ireland are as follows:—

(*a*) The indigenous strain proved a very poor competitor against weeds and against other sown species during the seedling year.

(*b*) The indigenous strain came into growth two or three weeks later than the commercial each spring. As a result of these two factors, the indigenous plots compared unfavourably with the commercial plots during the first two seasons.

(*c*) In the autumn of 1933 however, the persistent character of the indigenous strain began to make itself felt and comparison then showed in most cases little difference between the two types. By the spring of 1934 the advantage of the indigenous character was a little more pronounced and in 1935 in the majority of cases the indigenous plots are definitely better than the commercial plots.

(*d*) In a few instances the indigenous plot has been better than the commercial plot from the beginning. Such instances are always where the land is clean and in good condition and the general conditions favourable.

The general outcome therefore appears to be that this particular strain is a little too pronounced for North of Ireland conditions so that its advantage in the later years of the ley is offset by its relative disadvantage in the early years. This suggests that strains of a less pronounced type, intermediate in character between that used in 1932 and ordinary commercial, might be better for local purposes. It is hoped to lay down plots in 1936 with such a type.

(ii) *New Strains of Lolium perenne.*—Further pasture cuts and hay yields were obtained from the small-scale plots (referred to in the last report) during the 1935 growing season. Bearing in mind the trinity of *desiderata* good seed production, high hay yielding capacity and high pasture productivity, the best results to date have been given by a Scottish local strain and a Danish bred strain. The trial is being continued.

Industrial seed production.—One half of the plot of Aberystwyth élite perennial ryegrass sown at the North-West School, Strabane, in 1933 has been harvested a second time in 1935, the other half being ploughed and resown with the same strain in 1934, thus coming to first harvest in 1935. The seed yields are not yet available but the appearance of the two crops a week prior to harvest suggested that the proportion between first harvest and second harvest yields, with this strain, was better than is usual with commercial strains, and it is thought this may compensate to some extent for the relatively light crops usually obtained from indigenous strains at first harvest.

The County experiments sown in 1934 with the same Aberystwyth strain for the purpose of estimating hay and seed productivity have been harvested and results are so far available from four centres. Tentative conclusions based upon these four are:—

(*a*) Yields of hay were slightly heavier in all cases and averaged three hundredweights per acre heavier, from the indigenous than from the commercial sowings. This is important since the indigenous plot habitually *looks* the lighter of the two. The hay was also much more leafy in the case of the indigenous plots.

(*b*) Seed yields were exceedingly poor at all centres so far recorded from the indigenous strain, averaging approximately two hundredweights of uncleaned produce per acre against approximately five hundredweights from the commercial type. The yield from the indigenous plots moreover must be further reduced because it was generally much more weedy than the commercial produce. It appears that this strain also is too pronounced a type for our conditions and the small yield and dirtiness of the seed crop is no doubt in part referable to the same disabilities in early life as those noticed in connection with the 1932 sowings.

Seed mixture for littoral aerodrome.—Attention during the past year in connection with the trials in hand in collaboration with the Belfast Harbour Commissioners has been confined to the practical possibilities of native *Poa maritima* as a first colonist. An area of two or three acres of almost pure *P. maritima* which had developed strongly during the spring of 1935 was harvested in summer and yielded several hundredweights of seed in which the only appreciable impurity was chaff. The germination of the seed proved to be about 70 per cent. and this has been broadcast on a further clean area of new mud. *P. maritima* has proved itself capable of forming a skin on the salt " sleetch " in a couple of seasons sufficiently tough to carry light motor traffic and it is hoped that it will persist as long as saline conditions prevail, so that when it disappears the ground will be in a condition for sowing with rye-grass.

Weeds.—The more obvious effects of the rush cutting experiments at Hillsborough are becoming apparent and it is possible to form a few broad conclusions. It is clear that the plots regularly cut are much better grazed than the rest of the field and that the grazing is definitely helping to improve the condition of the turf. Secondly, it is interesting to note that cutting in June, July or August appears more effective than cutting in earlier or later months. This is noteworthy in view of the clear advantage of early cutting with many weeds such as thistles. Those plots cut two seasons running in each month from April to October are practically free of rushes but it is not yet possible to say how far the number of cuttings per annum may be reduced before serious loss of effect occurs. It is obvious that one cutting is insufficient and that two are noticeably effective but it cannot yet be said what is the best economic number.

Title of paper issued during the year.

1. Lineham, P. A., and Mercer, S. P.: Purity of commercial Italian ryegrass. Second progress report. *Seed Anal. Bull.*, **27**, 119-120, 1935.

HORTICULTURE AND GLASSHOUSE CROPS

13. LONG ASHTON FRUIT RESEARCH STATION, UNIVERSITY OF BRISTOL

FRUIT CULTURE.

I.—PLANT NUTRITION.

(a) *Rootstock Problems.*

Field Trials.—Records of the trial plots of apple trees on layered stock and seedling stocks have been continued, and the growth data up to 1934 have been analysed. From the results it appears that for certain comparable series on seedling and layered stock there is no difference between the two types. The increased size of the trees now makes many of the detailed measurements impossible, and these will be replaced by more general records, coupled with quantitative data regarding cropping.

Ninety standard apple trees of Newton Wonder worked on *Malus acerba* seedlings, were planted in grass to determine the variability in growth of the trees.

Further trial plots of apple trees on Long Ashton layered stocks have been planted at East Lambrook, Somerset (71 Newton Wonder standards) and at Pewsey, Wilts (132 Worcester Pearmain bushes).

Detailed records of growth and cropping in the experiment with Malling apple rootstocks are only continued with the variety Worcester Pearmain. The trees of Lane's Prince Albert have been utilised for chemical investigations during the year (see below).

In the plum rootstock experiment, the trees continue to show the differences previously described.

During the winter of 1934-5 a three acre plot was established to study variety and rootstock effects in pears. Ten popular varieties have been worked on various rootstocks—four quinces, two pears and miscellaneous seedlings. Quince C has already shown marked incompatibility with most scion varieties, while all the trees of Conference worked on Quince G have died.

The gales in September, 1935, caused 24 trees on this plot to break off at the stock-scion union, 14 on Quince C. and 5 each on Quinces A. and B.

Laboratory work.—Chemical investigations have been continued to determine the effects of several apple rootstocks M. II, V, VII, IX and B on the chemical composition of the terminal shoots of the scion variety Lane's Prince Albert. The results so far available for the period January to June do not show any striking differences due to rootstocks.

(b) *Stock and scion relationships.*

The effect of intermediate stem pieces.—The experiment in which the effects of Malling rootstocks Nos. II, IX and XIII used as intermediate stem pieces are under examination has been continued. The growth features of the trees where M. IX is used as the intermediate are similar to those where it is used as the rootstock.

The influence of the scion variety on root morphology.—It has been shown previously that certain scion varieties, e.g., York Imperial, Whitney and Tetophsky markedly influence the root morphology of seedling rootstocks. The work is being extended to other varieties.

The use of bench grafting in the production of standard trees.—Trials of standard apple trees raised from bench grafted material have been established. The young material is of excellent quality.

(c) *Manurial Experiments.*

Pot experiments.—In the experiment with Cox's Orange Pippin in soil from the Station manurial plots where the treatments are comparable with those given in the field trial, the trees in all series have made strong, healthy growth, the only points in evidence being slightly restricted shoot growth where the treatments " omit nitrogen " and " no manure " are given, and the development of slight leaf scorch, as autumn tints, in " no manure " and " omit potassium " series.

The results so far do not parallel closely the field observations, where potassium deficiency has led to complete failure of the trees.

In the Cox's Orange Pippin sand culture experiment, where four rootstocks are under test, the trees developed much leaf blotching in the spring which appeared to be due to " Cox Spot " and magnesium deficiency, the trees becoming seriously defoliated. The magnesium deficiency seemed to be due to the high potassium content of the nutrient solution and was entirely overcome by raising the magnesium content of the diet. Attempts to revive the apple trees, variety Bramley's Seedling, in sand cultures, previously subjected to deficiency treatments, having had little effect; it is proposed to utilise the trees at the present stage to study problems relating to the balance of nutrient elements in the nutrient solution.

Laboratory investigations.—These are still in abeyance whilst attention is being concentrated on nitrogen and carbohydrate cycles and relationships.

Field experiments.—(i) *At Long Ashton.*—The disastrous frost of 17th May affected the records for the season very severely as it led to the total loss of crop on raspberries, strawberries and all apples with the exception of the variety King Edward, where there was a medium crop, whilst the blackcurrant crop was also seriously reduced. The loss of crop re-acted on the growth of the various plants, leading to strong vegetative growth. In the raspberry trial, the loss of crop led to strong growth on all plots and because of this it was necessary to thin out the new canes during the summer. The nett result of the season has been that the plants on all plots, with the exception of Nos. 8 and 9, have made strong growth and differential manurial effects are scarcely noticeable.

During 1935 the first stage of the time of manuring experiment on apples, varieties Allington Pippin and Edward, was concluded. From 1936 onwards, only one half of the treated area will be manured as previously whilst the remaining half will receive no manurial treatment, the main purpose in the future being to follow the onset of starvation symptoms on the unmanured trees which have hitherto been grown on a high plane of nutrition.

In the apple deficiency experiment, variety Lane's Prince Albert, the trees on the poor growth area of the plots which receive " no manure " or " omit *K* " treatments are beginning to show die-back of main branches and are excellent specimens of potassium starved trees.

A notable feature during the season was the effect of the autumn gales on the differently manured trees. Where *K* was omitted the whole of the foliage on the trees became dried out and was entirely brown.

The records for growth and cropping of the bushes in the blackcurrant manurial experiment have been analysed statistically to the end of the season 1934. These show significant effects due to " no manure " and potassium deficiency, where growth and yields are low, whilst it appears that omission of nitrogen and phosphorus will also show significant decreases in future.

In 1935, the bushes on the " omit phosphorus " plots have shown marked yellowing of the foliage and premature defoliation, and it appears likely that the effects of this deficiency will become very pronounced within the course of the next season or two.

The above manurial experiments have now reached a stage when the trees and bushes can provide excellent material for chemical and physiological studies and it is hoped that these will be possible during the next few years.

The progress of the continuous manurial experiments on strawberries was interrupted during the season by the May frost and the summer drought. As a result of these it was decided to clear the beds and clean them. A green crop of mustard was taken during the summer, and weight recorded before ploughing in: it was found that lowest weights were obtained from the " no manure " and " omit *N* " plots. The beds are to be replanted in Spring 1936.

(ii) *At other centres.*—During the year, the result obtained on the various bush fruits—black currants, gooseberries and strawberries—to the end of 1934 in the experiment at Cannington Farm Institute have been analysed.

The main points which have emerged in the strawberry experiment are as follows:—

> Largest crops were obtained from " complete artificials " and " omit nitrogen " treatments, and poorest crops from " omit potassium " and " omit phosphorus "; it is not clear whether the poor result for " omit phosphorus " is partly due to low potassium conditions on that plot. The order for vigour and longevity of plants on the plots in 1934 was as follows:—complete artificials, omit nitrogen, omit phosphorus, dung, no manure, omit potassium. The outstanding result of the experiment has undoubtedly been the poor results following the omission of potassium.
>
> In the Cox's Orange Pippin experiment in Herefordshire the trees continue to make excellent growth. The crop in 1935 was destroyed by the May frost.
>
> An experiment on apples, varieties Bramley's Seedling and Early Victoria, has been established in a commercial plantation in Cheshire. Remarkable results from potassic fertilisers have been obtained hitherto in this plantation. The present experiment will be utilised mainly to determine the effects of the treatments " no manure ", *N*, *K*, *NK*, on fruit quality.

(d) *Soil moisture experiments.*

The 1934 crops from the high moisture series were stored under ordinary and cold store conditions and, in the ordinary store, where it was possible to compare crops from both " outside " and " inside " (i.e. grown in greenhouse) trees. The proportion of Bitter Pit from the " outside " trees was 42 per cent. and from the " inside " series 93 per cent.

Following on the observations of 1934 that the " outside " trees appeared of lower nitrogen status than the comparable trees grown in the greenhouse, attempts were made to raise the nitrogen level of half the trees in each case appreciably by means of a substantial spring dressing of nitrate of soda. The dressing, although causing foliage damage to the treated trees, failed to alter the low nitrogen appearance of the outside trees to an appreciable extent and the problem will require further attention in 1936.

Many of the low soil moisture series trees were in very poor condition in 1935 and it was considered desirable to terminate these " dry " treatments at the end of the season.

In 1935 the crops on both " inside " and " outside " trees were rather small, due mainly to Codlin Moth damage, and also to frost effects on the " outside " trees, but sufficient fruits were harvested from the lower nitrogen batches of trees to carry out keeping tests in the ordinary temperature store.

(e) *Tree shaping and pruning.*

Crop records on the apple trees used in this experiment were vitiated in 1935 due to the frost in May.

(f) *Bark ringing.*

Observations in 1935, another drought season, has confirmed the observations made in 1933 and 1934 on the efficiency of various ringing methods. The superiority of the method involving the immediate covering of the " ring " with rubber tape has been clearly established.

(g) *Biennial bearing of apples.*

The experiments have been continued as previously reported. The total loss of crop from all trees in 1935, due to frost, will introduce difficult complications, since all trees are expected to crop excessively in 1936 after the " off " year of 1935.

(h) *Seasonal cycles of nitrogenous and carbo-hydrate materials and of mineral constituents in apple trees.* (10, 28.)

The investigations relating to rootstock effect have been continued (See 1 (*a*) Laboratory Work).

(i) *Surveys of fruit soils.*

Mapping has been continued in the cider fruit areas around Martock, Somerset, but progress was again greatly hindered by the summer drought. (24.) The soils of the Research Station have also been mapped on a scale of 25 inches to 1 mile.

(j) *Factors affecting the storage qualities of fruits.*

(See Section VIII.)

II.—INVESTIGATIONS ON SOFT FRUITS.

(a) *Strawberries.*

Cultural problems.—Further observations in "strain" trials have confirmed previous results, especially that "goodness" in strains is often associated with freedom from serious diseases.

Of the newer varieties under trial, Pilnitz cropped heavily in 1935 although the plants were of rather poor vigour. Western Queen suffered severely from frost, whilst Gaddesden was not superior to Royal Sovereign and so far it has not been possible to distinguish botanically between these two varieties.

The variety Huxley has proved an excellent pollinator for both Oberschlesien and Tardive de Leopold and since it can be planted with confidence in the field it should be useful where Royal Sovereign does not succeed.

A point of interest which has emerged from the pollination studies has been that the pollen parent has affected the shape of the fruits of Oberschlesien, Royal Sovereign producing rounded or wedge-shaped fruits and Huxley conical and pointed ones.

(b) *Raspberries.*

Cultural problems.—"Rogueing" and selection of mosaic-free stocks have been continued, the main object being to raise pure lines of disease-free material for experiments relating to cultural methods.

(c) *Blackcurrants.*

The experiments comparing the effects of hard and light pruning of several varieties have been continued.

An analysis of the cost of picking the commonly grown black currant varieties on certain of the Long Ashton plots has been made (30).

The results show that the cost of picking, which comprises a large item of production cost, varies widely with different varieties.

(d) *Redcurrants.*

Variety and strain trials.—A variety trial is in progress which includes the new sorts, Laxton's No. 1, Laxton's Perfection and Northern Star. The former two appear to be of outstanding merit.

A strain trial of the variety Raby Castle was commenced in winter, 1934-35. This has arisen from observations that, whilst the variety is often reported as an unsatisfactory cropper, outstanding cases of heavy cropping plantations are known.

(e) *Gooseberries.*

Work on variety nomenclature and classification has been continued; the variety trial will be concluded shortly. The experiment on summer pruning has been continued as previously outlined.

III.—Fruit Breeding.

Observations and selections of seedlings of various fruits were continued.

Crop records in the larger trials were seriously vitiated by frost as also were observations on the fruits of newer seedlings. Appreciable crops were obtained only on pears, blackcurrants and blackberries. The main points of note during the season were as follows:—Several seedling pears appeared of promise and worthy of propagation; the best selected blackcurrants again gave satisfactory yields; seedling raspberries from crosses of Viking x Preussen produced good crops in spite of the frost; several of the strawberry seedlings raised and selected to obtain freedom from disease have remained satisfactory as regards vigour and health.

Wisley Variety Trial Scheme.

Apples.—The varieties Herring Pippin and St. Cecilia have been eliminated from the trials, the former because the fruits are too large and soft for commercial purposes and the latter because of its sensitivity to sulphur damage.

Blackcurrants.—No fresh point of note has emerged owing to frost effects.

IV.—Pests and Diseases and their Control.

(a) *Reversion disease and big bud of blackcurrants.*

Slight attacks of Big Bud have developed on several bushes during the seasons 1933, 1934 and 1935, but in every case the attacks were subsequent to reversion.

(b) *Raspberry moth or " red grub "* (*Incurvaria rubiella*).

Two methods of control of this pest are being tried:—

(i) Soil treatment by watering of the stools at the time of bud burst (which coincided with the movement of the larvae from their winter cocoons) with low concentrations of tar and petroleum oils.

(ii) Banding of the canes near the base in spring to trap the larvae, with a preparation which could be applied as a spray.

The tar oil method provided the more promising results, the banding compound failing owing to its absorption by the canes.

(c) *Apple blossom weevil.* (*Anthonomus pomorum.*)

Observations have been continued with a view to determining the seasonal variation in the periods of oviposition. The ultimate aim is to attempt to control the beetle by means of contact and repellant washes.

(d) *Woolly aphis.* (*Eriosoma lanigera.*)

Treatment of nursery stock by dipping in a 10 per cent. tar oil emulsion has been shown to result in about 70 per cent. control of woolly aphis. Attempts have been made to improve on this method by hot water treatment—immersion of the trees in water for 30 minutes at 110° F. In preliminary experiments the latter method provided a complete control of the pest, and also destroyed the eggs of pests such as aphis and sucker.

The use of refined kerosenes for controlling woolly aphis on established trees, although efficient in killing the pest, may result in serious damage to the trees and cannot be recommended.

(e) *Plum sawfly.* (*Hoplocampa flava.*)

Field trials in which special attention was given to " timing " of spray applications showed that nicotine and lead arsenate washes failed to provide a commercial control of the pest.

Laboratory experiments showed that it was only possible to kill the larvae with nicotine when the spray was applied when they were on the stems and foliage. Young fruitlets could not be wetted with a wash containing 20 lbs. of sulphonated lorol per 100 gallons wash and burrowing larvae were not killed.

A derris wash, containing derris root and sulphonated lorol, gave some measure of control when applied three weeks after full petal fall.

Detailed observations on the hatching of the eggs and the habits of the young larvae appear necessary.

(f) *Control of pear midge.* (*Contarinia pyrivora.*)

Attempts to control this pest with a pre-blossom derris wash showed that the method was not effective.

(g) *Strawberry pests.*

Tarsonemid mite.—Further experiments have confirmed the efficacy of hot water treatment of runners as a means of controlling this pest. It has also been shown that great care is necessary to prevent re-infection of treated stock from neighbouring infested beds.

(h) *Control of pests and lichen on lichen-infested trees.*

The above problems present serious difficulties in many west country farm orchards. Tests are in progress using emulsions prepared from low and high boiling creosote oils.

(i) *Red willow beetle.* (*Melanopa populi.*)

The life history, host plants of, nature of injury from and methods of controlling the red willow beetle were determined. The beetles and the larvae were both controlled by a combined wash containing lead arsenate, derris and a wetter. (See also Section V.)

(j) *Die-back in plums.* (*Bacterial stem canker.*)

The field trials previously reported were continued. No further cases of die-back have developed in the commercial plantation concerned and all trees supplied for the special plot established at that centre have made excellent growth, Burbanks Giant Prune on Myrobolan B. being outstanding in this respect.

(k) *Die-backs; fruit spots and fruit rots of apples.*

As mentioned in last year's report, it has been established that many fungi capable of causing fruit spots and fruit rots of apples occur commonly on branches and twigs of the trees. These fungi may either exist in an active parasitic condition, causing cankers, or may occur saprophytically on dead parts of the tree. Thus die-backs, either physiological or pathogenic in origin, provide a favourable culture medium for such fungi (18).

During 1935 attention was concentrated on *Diaporthe perniciosa* in its relation to die-backs, cankers and fruit and leaf spotting.

(l) *Apple canker.*

Spraying trials on young trees were continued, using Bordeaux-oil mixtures. The spraying treatment consisted of Bordeaux-cotton seed oil in October, 1934, followed by Bordeaux-white oil in April, 1935.

Attention has been given to canker infection through leaf scars in the cider variety Kingston Black. Experiments with a view to controlling such cankers by means of Bordeaux-oil sprays applied at different times during the winter have been initiated.

(m) *Strawberry diseases.*

Root rots.—Further inoculation experiments to test the pathogenicity of fungi commonly associated with failures of strawberries in the field have failed to show the degree of root killing associated with failures and it is suspected that in the majority of these, unfavourable growth conditions are primarily responsible for the poor results.

Virus disease—"Crinkle".—A disease closely resembling the American " crinkle " has been found in South-West England recently. It has recently been successfully transmitted by grafting at East Malling, and has been shown to be distinct from "yellow edge". The disease is more severe on Royal Sovereign than on the darker-leaved varieties; it has been found possible to keep several strains of Royal Sovereign growing in isolation free from the disease.

"*Crimp*".—The name "crimp" is given in America to a peculiar ballooning and distortion of strawberry leaves associated with the presence of the eelworm *Aphelenchoides Fragariae*. A very similar condition has been noticed on "Kooi" plants in the Cheddar area and the same eelworm was found to be prevalent on these. Soil brought from infected fields induced the occurrence of similar symptoms and also of "red plant" on hot-water treated runners of several varieties.

(n) *Blackberry stem rust* (*Kuehneola albida*).

Single spraying treatments in 1934 with Bordeaux mixture and copper lime dusts were judged in 1935 to have been ineffective.

In further experiments an attempt has been made to maintain adequate protection of the new canes during the season by means of a succession of spray applications, three applications being given as under:—

24th April—4-8-50 Bordeaux mixture + 4 per cent. white oil.
20th May—4-8-50 Bordeaux mixture + 3 ,, ,,
1st July—4-8-50 Bordeaux mixture + 3 ,, ,,

The spray proved very retentive and caused no apparent damage. The results will be judged in spring, 1936.

(o) *American gooseberry mildew*.

The use of a soap and soda spray against this disease in late July caused some defoliation of the sulphur-sensitive varieties Langley Beauty and Early Sulphur.

(p) *Virus diseases of tree fruits and small fruits*.

Tree fruits.—Observations have been continued on leaf mottlings and distortions of apples and plums as a preliminary to more detailed investigations concerning the possible relation of these to mosaic diseases.

Small fruits.—The work of raising seedlings of raspberries, blackcurrants, redcurrants and strawberries under insect free conditions for work on virus diseases has been continued. (*See also* Section V.)

V.—SPRAY MATERIALS AND CONTROL METHODS.

(a) *Combined washes*.—Particular attention has been given to the use of supplementary materials facilitating the mixture of direct insecticides with protective fungicides (9).

For laboratory trials, techniques for standardised spray application and toxicity testing were evolved and improved methods developed for rearing populations of test insects.

Washes containing water soluble spreaders:

(i) *Evaluation of spreaders in water solution.*—Investigations have shown that certain physico-chemical tests are adequate for the preliminary examination of these products. The properties investigated have been (*a*) wetting, determined by receding contact angle, (*b*) spreading, determined by area of spread tests, (*c*) penetrating, determined by time of sinking tests. With materials of similar molecular structure a good correlation has been found between spray performance and certain physical properties.

(ii) *Incorporation of spreaders with direct insecticides and protective fungicides.*—Field trials have been made, using lime sulphur-nicotine as a test insecticide against apple sawfly, and Bordeaux mixture as a test fungicide against potato blight. It was found that sulphite lye (6 pints per 100 gallons), sulphonated lorol (8 oz. per 100 gallons with lime sulphur-nicotine, 4 oz. per 100 gallons with Bordeaux), and several proprietary spreaders, increased the efficiency of the spray. Eight oz. of sulphonated lorol per 100 gallons Bordeaux mixture decreased the efficiency of the fungicide.

Washes containing oil emulsions.—The motives for the inclusion of an oil emulsion in a combined wash are (*a*) the conferring of spreading and penetrating properties, (*b*) the utilisation of the ovicidal properties of the oil.

(i) *Tests of oil-lime sulphur against apple scab and capsid.*—In preliminary laboratory trials of 1 per cent. lime sulphur mixed with 5 per cent. of a refined white oil emulsified with sulphite lye, it appeared that the mixture was not fungicidally inferior to 1 per cent. lime sulphur on unleached apple leaves, but that the retention of the spray deposit on leaching was impaired by the addition of the emulsion. A field trial of 3 per cent. lime sulphur mixed with the same emulsion and applied to apples at the green-flower stage, showed no diminution of scab and capsid control when compared with parallel blocks in which these materials had been applied separately.

(ii) *Tests of oil-lime sulphur against currant capsid and big bud.*—Field trials have shown that 8 per cent. lime sulphur mixed with 5 per cent. refined white oil emulsion may be safely applied to blackcurrants up to flowering time for the combined control of capsid and big bud. The substitution of the white oil by a spindle oil causes serious injury to the bushes.

(iii) *Tests of oil-Bordeaux mixtures.*—Bordeaux-oil spray mixtures tested against potato blight showed a lower copper retention on foliage when a mineral oil emulsion was used than when cotton seed oil was employed. In spraying trials on cider apple varieties, the Bordeaux-mineral oil combination satisfactorily controlled red spider but caused leaf drop on the variety Court Royal.

Washes including ferrous sulphate.—The combined wash of lime sulphur and lead arsenate has phytocidal properties which are said to be reduced by the addition of ferrous sulphate. The admixture of ferrous sulphate increases the visibility of the spray deposit and may enhance its tenacity and toxicity. Trials relating to these points were continued in 1935 at Long Ashton and at Overbury. In the former trial there was no crop, but no leaf damage was observed; at Overbury there was evidence which suggested that the ferrous sulphate prevented the normal growing out of the fruit.

(b) *Copper fungicides.*—A series of cuprous and cupric derivatives have been obtained in forms permitting of dilution with water to give satisfactory suspensions.

Laboratory trials against apple scab.—Tests carried out with leached spray deposits on apple leaves showed that at a concentration of 2 gm. Cu per litre the following compounds possessed some fungicidal power—cuprous cyanide, cuprous sulphite, cupric oxalate and copper gamma sulphonate. None of these compounds, however, was as effective as Bordeaux mixture of the same copper content.

Laboratory tests against cinnabar moth larvae.—Tests made with larvae of cinnabar moth on foliage sprayed with cuprous cyanide demonstrated that this material was highly distasteful to the insects and, if consumed, was eventually toxic.

Field trials against potato blight.—In 1934, cuprous oxide, cupric oxide and cuprous cyanide pastes were tested against potato blight in comparison with Bordeaux mixture. The cupric oxide proved inferior and the other pastes equal to Bordeaux mixture of the same copper content. Estimation of the copper retained on the foliage showed a lower figure for all the paste preparations than for Bordeaux mixture, indicating a greater "availability" of the copper derived from the cuprous oxide and cyanide preparations.

In 1935, in addition to the materials used in 1934, Burgundy paste and copper silicate, sulphite, oxychloride and phosphate were included. Although the general level of control obtained was low, owing to the existence of infection before spraying, all the paste preparations gave a better "blight" control than the Bordeaux mixture. Cupric oxide was apparently much more effective in 1935 than in 1934 possibly owing to its tenacity under wet conditions.

Field trial against pear scab.—A trial of cuprous cyanide, in comparison with an oil-Bordeaux wash, against pear scab, was rendered almost worthless by frost damage. On a very scanty crop there was an indication that cuprous cyanide had exerted some fungicidal effect but was inferior to the Bordeaux mixture.

(c) *Non-poisonous nicotine substitutes.*

Laboratory investigations on derris.—It has been established that the insecticidal properties of derris extract do not reside exclusively in the crystalline rotenone fraction. From the economic aspect it would therefore appear better to utilise the complete resinous extract provided that a suitable solvent can be found. Examination of Dioxan and Cyclonol for this purpose is being carried out.

Field trials with rotenone and with derris extract.—In 1934 it was established that a rotenone wash (1·2 oz. rotenone per 100 gallons) was equivalent in toxicity towards capsid bugs and apple sawfly to a wash containing 8 oz. nicotine per 100 gallons. Trials in 1935 with a derris extract of similar crystalline rotenone content gave satisfactory control of apple sawfly.

(*d*) *Mode of action of nicotine applied before egg-hatch on apple sawfly.*—Laboratory tests were made in 1935 in an examination of the hypothesis that nicotine acts as an ovicide. Apple blossoms known to be infested with sawfly eggs were treated with nicotine washes and kept under observation. It was proved that nicotine did not act as an ovicide but that larvae hatched normally and survived provided that they were prevented from eating the treated calyx tissue.

(e) *Investigations on ovicides.*

Laboratory tests of substitutes for tar-oils.—If an oil-soluble aphis ovicide of non-phytocidal character were available, this material could be incorporated in a petroleum oil spray, thus obviating the necessity for separate petroleum and tar-oil applications. In 1934-35 materials of this type found to be of promise were certain organic thiocyanates and xanthate compounds, but the results need extended confirmation before publication.

Trials against red spider.—Systematic trials have been made of the action of selected hydrocarbons and synthetic organic derivatives upon the eggs of red spider. A spray application of 5 per cent. spindle oil on trees of Lane's Prince Albert at bud burst gave a satisfactory kill of red spider eggs but caused considerable bud damage.

Trials against currant capsid.—A field trial in 1934-35 showed that a wash containing 4¼ per cent. high-boiling neutral tar oil and 4¼ per cent. high-boiling petroleum oil gave a satisfactory control of capsid bugs. Half white and spindle oils were equally efficient as capsid ovicides. For the emulsification of the oils, oleic acid was found efficient.

(f) *Standardization of insecticides and fungicides.*—A paper on draft specifications and methods of analysis for tar and petroleum oil preparations was published in 1935 and is now awaiting consideration by manufacturers, oil distillers and others interested (14). Attention has been paid to the hydrated limes and to the organo-mercury seed disinfectants, and collaborative work on the latter group has been arranged with workers at Aberystwyth, Belfast and Reading.

(g) *Fungicidal action of sulphur.*—The reduction of sulphur to hydrogen sulphide by the action of living plant cells has been further investigated. Previous work had indicated that the reduction took place as a result of a complex reaction between a constituent or constituents of the living cell related to cysteine and sulphur, an organic sulphur compound being formed as an intermediate stage. The existence of this intermediate substance has now been proved. It is a gaseous compound, containing carbon and sulphur, very unstable at ordinary temperatures and yielding in combination with certain metals compounds which enable it to be distinguished from hydrogen sulphide.

The nature and properties of this substance are being further investigated.

(h) *Spraying technique.*—Work has been continued in connection with plantation and grass orchard problems.

Special attention has again been given to the use of the " mobile " system and comparison of its use with a system involving laying out of rubber hose; to use of various spray pressures and to development of improved accessories, particularly spray guns. The changes effected over a six year period have resulted in a marked decrease in spraying costs, in addition to vastly improved spraying results.

FRUIT PRESERVATION AND PRODUCTS.

VI.—CIDER.

(a) *Variety trials.*—Competitions for varieties of cider apples and perry pears were again held. There were 113 entries, of which 10 were pears. The quality of the ciders was above the average but did not reach the standard of the 1933 crop (25). Perries were only of fair quality. Cider varieties of interest were a new variety tentatively named Cowsden Bramley, which gained 1st Prize in the Sharp Class. George James, 1st Prize Mild Bittersweet Class and River Apple, 2nd Prize Bittersweet Class.

(b) *Action of cider on metals.*—Methods of preparing metal strips for testing in cider have been examined. In the case of aluminium, the heating treatment usually applied has definitely reduced the resistance of the metal to corrosion. Cleaning with caustic soda is under test. An attempt is being made to follow the course of corrosion by microscopic methods.

Samples of aluminium (99·5 and 99·7 per cent. pure), " cidendum " and special cast iron and various lacquers and enamels coated on metallic surfaces are undergoing trial.

(c) *Centrifuging of ciders.*—Further experiments have been made to determine the effect of modifications of centrifuge practice on cider quality and the contents of nitrogen and yeasts. Previous results have been confirmed and the usefulness of centrifuging abundantly proved.

(d) *The rôle of pectin in cider-making processes.*—Experiments on the decomposition of pectin during fermentation, maceration and storage, described in the previous report, have been continued. (1, 2.)

The need for a rapid and reliable method for evaluating dried apple pomace, to be used for pectin extraction, is urgently needed and investigations to this end have been commenced.

(e) *Dilution of cider.*—Attempts have been made to produce a new type of beverage by dilution methods. The methods used have consisted in adding acidulated syrups to fresh juice, unpressed pomace and to once pressed pomace prior to re-pressing. The latter two methods yielded products of fruity character.

(f) *Maceration treatment.*—Experiments previously described (26) were continued to test whether the proportion of culinary apple juice to a given amount of bitter-sweet pomace could be increased. A cider from three parts culinary juice to one part pomace was equal in quality to one prepared from two parts culinary juice and one part pomace.

(g) *Suitability of woods for cider storage.*—The coniferous woods previously used (27) were again employed to follow the effects of the previous immersion in cider in removing undesirable properties. Adverse effects were still discernible in all cases.

(h) *Concentration of apple juices and ciders by freezing.*—Juices have been frozen and centrifuged in a crystal separator, concentrates with gravities ranging from 1·200 to 1·283 (45-57 per cent. sugar) being obtained. Yields were low owing to the inefficiency of the separator obtained. A perforated basket fitted to a laboratory centrifuge gave efficient separation of ice from juice. The flavours of the concentrates were superior to samples concentrated *in vacuo* at 40° C.

Three ciders were treated, products with 6-8 per cent. alcohol being obtained from ciders containing 3-4 per cent. alcohol. The ice crystals, however, retained 0·48-1·28 per cent. alcohol.

(i) *Low temperature keeving of apple juice.*—The latest French method of keeving fresh juice at 2-4° C. was tested on twelve 10 gallon casks of various juices. Control casks were kept in the Cider House at 16° C., and similar casks were quickly cooled to 4° C., and maintained at that temperature for six days. Little difference was noted in clarity except in two cases where samples in glass jars at 4° C. showed definite flocculation which was absent in the control jars. More soluble pectin remained in the low temperature juices than in the others, the reason probably being the inhibition of pectin decomposing enzymes by the low temperatures.

VII.—FRUIT PRODUCTS.

(a) *Juices.*—In filtration trials with a plate and frame filter on two fresh juices, satisfactory clarity and flow of juice were achieved.

(b) *Syrups.*—Trials have been made to determine the differences in flavour and keeping quality of 45 per cent. sugar syrup when preserved by pasteurisation or by sulphur dioxide. Both methods have been efficacious in preventing fermentation, since June-July, 1934, even where SO_2 was used in quantities considerably below the maximum percentages allowed by law. Slight yeast growth has been observed in syrup preserved with 50 parts per million of SO_2.

Heavy syrups have been filtered effectively with a plate and frame filter.

Fruit syrups have been shown to give attractive beverages when mixed with milk in the proportion of 1 syrup, 5 milk, using heavy syrups, or 1:4 with 45 per cent. syrups, and these are now being used commercially.

(c) *Squashes.*—Improved methods of preparing fruit squashes have been worked out. Preliminary sieving through a $\frac{1}{8}$th-inch sieve, followed by $\frac{1}{64}$ th-inch sieve has removed all but a negligible number of seeds. The remainder can probably be removed by passing the finished squash through the $\frac{1}{64}$ th-inch sieve. 300 parts per million SO_2 are effective in preventing fermentation. It has not been possible so far to obtain a form of deposit similar to those in citrus squashes.

(d) *Wines.*

Strawberry.—Increasing the dilution of fresh juice resulted in more complete fermentation; fresh juice, after sweetening, ceased fermentation at a gravity of 1·064, whereas when diluted 50:50 the final gravity was 1·015.

Diluted juices produced clear full-flavoured wines but pure juice products were too sweet and of rather coarse flavour.

Gooseberry.—The effect of adding a portion of the pressed fruit residue to a fermenting juice, with a view to obtaining a beverage of fuller "body," is being studied, but so far results have been inconclusive.

Two wines were produced with definite "hock" characters.

Loganberry.—The effects of dilution of juice and of pomace addition have been investigated. An excellent wine was made from a 1:25 diluted juice to which some finely divided press cake was added, the product being remarkable for its fresh fruit flavour.

Miscellaneous fruits.—Pleasant wines have been produced from raspberries, wortleberries, redcurrants and Youngberries.

Use of various sugars and pure wine yeasts.—The effects of various sugars, added to juices to increase the amounts of fermentable sugar, and of different strains of yeasts, used in fermenting the sweetened and subsequently pasteurised juices, have been ascertained. The sugars employed were cane sugar, liquid glucose and white brewer's invert sugar, whilst the yeasts used were Steinberg, Laureiro (port wine), Rissling, Champagne No. 295 and Vine yeast No. 305.

Glucose sweetening was unsatisfactory, as only 35 per cent. of its weight comprised fermentable sugar. Initial fermentation was of a violent character, but only 6 per cent. of alcohol was produced and the flavours of the wines were poor.

Sucrose and brewer's invert sugar gave satisfactory results, similar in character.

The best yeasts were champagne No. 295 and Steinberg.

Yeast nutrition problems.—Failure to obtain complete fermentation of sweetened fruit juices has led to attempts to stimulate yeast activity by the addition of possible nutrients.

The following nutrient substances were each added in four different amounts to a juice obtained by maceration of once-pressed loganberry pomace with excess water:—potassium dihydrogen phosphate, magnesium sulphate, calcium phosphate, ammonium nitrate, ammonium phosphate, Mayer's solution, Liebig's extract and yeast extract. Mayer's solution accelerated fermentation to the greatest extent, whilst magnesium and calcium salts were associated with slight retardation.

Other results (see *Wines*) suggest that incomplete fermentation may be due to the presence of a naturally occurring yeast inhibitor rather than to insufficiency of mineral nutrients.

Maturing of wines.—Experiments are in progress on methods of artificially maturing wines. Aeration and the addition of oak shavings both at cellar temperatures and at 130° F. are under test.

Economics of fruit products manufacture.—Attempts are being made to assess the costs of certain items in the manufacture of fruit products. Questions relating to the effect of price of raw materials on the finished products, the position regarding quantities and qualities of surplus fruits available year by year, and the best means of obtaining bulk supplies of surplus fruits, are under consideration.

(e) *Fruit pulp investigations.*—(See special report on the use of sulphur dioxide in fruit preservation: page .)

(f) *Fruit bottling.*—Experiments using previously heated bottles and boiling liquid have been continued. The products made by the method are in course of examination.

(g) *Fruit canning.*—The commercial method of exhausting cans has been adapted to domestic canning. The quality of the products requires testing over a period of months.

(h) *Jam making.*—The parts played by acid, pectin and sugars in the setting properties and keeping qualities of jams are under investigation.

VIII.—STORAGE EXPERIMENTS.

Storage Qualities of Fruits.

1934 was notable as a season of abnormally heavy fruit crops and it was thus possible to carry out a large experimental programme. The summer of 1934, like that of 1933, was very hot and dry and drought conditions obtained in many fruit plantations. The repetition of the 1933 weather conditions enabled certain results obtained in that season, relating to the effects of the hot and dry conditions, to be checked. In particular special attention was again given to the effects of the conditions on the quality and storage properties of the variety Worcester Pearmain.

Experiments during the reason were confined entirely to apples.

The main storage investigations related to the following subjects:—

Climatic factors, with special reference to the variety Worcester Pearmain; rootstock effects (including Northern Spy) and manurial treatments and their inter-relationships; Bitter Pit, with special reference to its occurrence in the variety Bramley's Seedling in the Wisbech area; drought effects; irrigation.

The analysis of the results is not yet complete but the following points arising from the data may be mentioned:—

(i) The abnormally fine weather was again associated with considerable storage breakdown in Worcester Pearmain.

(ii) Significant effects on storage quality—rots and breakdown—due to rootstocks and to the manurial treatments N, K, NK were obtained.

(iii) Extensive Bitter Pit developed in the various samples of Bramley's Seedling obtained from the selected orchards at Wisbech and the amount of Bitter Pit at the different centres varied greatly. High soil moisture did not appear to be a predisposing factor since the soils in all cases remained in a dry state throughout the season. Fruits exposed to the sun showed much more Bitter Pit than those fruits from shaded positions of the tree. Later picked fruits did not develop less Bitter Pit than those gathered earlier. Bitter Pit developed extensively both in ordinary and cold stores but appeared later under the latter conditions. These results will require confirmation over several seasons before they can be considered as established and arrangements have been made for the continuation of the experiments at the selected centres.

(iv) Droughted fruits, in which size was severely restricted, showed excellent keeping qualities in store, other than shrivelling.

(v) Irrigated fruits exhibited early storage maturity and premature flesh breakdown.

Chemical Investigations.

The work of determining the character of the major chemical constituents of the main samples stored was continued, special attention being given to samples from experiments to be continued over a number of years. It was considered important to examine the composition of the fruits from the Bitter Pit centres in order to see whether any lead could be obtained from the chemical data.

IX.—WILLOW CULTURE AND THE UTILISATION OF WILLOWS.

(a) *Variety trials.*—The original variety trial beds, planted in 1922-1923 have been grubbed and the land fallowed during 1935. The beds will be replanted with the original varieties as soon as the land is ready.

(b) *Hybrids.*—The new hybrid varieties of Basket Willows have produced better crops than old varieties grown from cuttings. A similar result was shown in the case of Seedling Bat Willows when compared with young trees of the same age raised from cuttings. New hybrids have been raised.

(c) *Manurial trials.*—Manurial trials on basket willow varieties are in progress. The season 1935 was unfavourable for increases from manures, the increase obtained, based on yields, being at the rate of approximately £1 per acre.

(d) *Pests and diseases.*

(i) *Red willow beetle.* (*Melanopa populi*).—The life history, host plants of, nature of injury from and methods of controlling the red willow beetle were determined. The beetle and the larva were both controlled by a combined wash containing lead arsenate, derris and a wetter.

(ii) *Rust.* (*Melampsora Amygdalinae*).—The development of cankers on early and late cut rods is under investigation.

(e) *Cricket bat willow problems.*—The study of the characters which affect the value of cricket bat timber has been continued. Sets have been raised under conditions which may lead to such treatment of young trees when being grown in the nursery, as will eliminate the causes of defects in mature timber. The development of latent buds and initial root masses and their effects on the wood is being investigated. The results of two years' experiments on the effects of the lateral growths on the main stem is being prepared for publication.

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14. EAST MALLING RESEARCH STATION

I.—POMOLOGY.

TREE FRUITS.

(a) *Rootstock investigations.*

Apples.—The previous year's heavy crop was reflected to a varying extent on the trees in the main apple rootstock trial in a reduction of blossom: but these effects were overlaid by the severe frosts in May, which wiped out the crops on all varieties. Work was concentrated on growth recording of mature trees. With the grubbing of old trees of Worcester Pearmain and Bramley's Seedling on the whole range of rootstocks, data of " head " and root growth in relation to performance have been obtained and analysed (12).

Analysis of the root observations on trees lifted during the last two winters indicates that the root systems of worked trees resemble generally those of the young unworked stocks. The exceptions to this rule occur with both scion varieties, and are probably due to differences in age rather than to scion effect. If the rootstocks are classified according to the early vigour of the scion worked on them, there is a gradual increase in the number of roots in passing from the most dwarfing to the most vigorous, but the exceptions to this generalisation are too notable for it to be used as a basis for theoretical discussion (5, 6).

Detailed records of the 8-year old trees of Lane's Prince Albert on Long Ashton clonal rootstocks have been continued for comparison of the rootstocks with East Malling types. An intensive study of Northern Spy as a rootstock is also in progress, including investigations of its behaviour at all stages.

A trial to study the effect of rootstock influence on planting distance from the economic aspect has been planted on a grower's farm. At the Station a complex trial of Cox's and Worcester single cordons on rootstocks I, II, IV, VII, IX and XII has been planted, designed to compare (1) planting at 1 ft. 9 ins. and 3 ft. 6 ins. (2) summer, and winter and summer, pruning. Two manurial treatments can also be superimposed later if desired.

Mechanism of rootstock effect.—Existing experiments were continued, and one was concluded. The 12-year old trees of Early Victoria, Oslin, Keswick and Manx Codling, on their own roots and on rootstocks II and XV were lifted and detailed data added to those collected during their lifetime.

A trial has been commenced in which stocks vegetatively derived from mature trees of recorded performance are budded with the variety worked on the parent stock, for comparison with the parent.

Pears.—The existing trials of quince and layered free pear stocks have been continued (11). In spite of a good show of blossom no fruit was set except on Conference, and these were misshapen and almost seedless. Trees of the more shy bearing varieties have been set aside for experiments on this failure to crop.

A summary of the available information on incompatibility in pears has been prepared, as a prelude to research on this question.

Trees of four varieties of pears on two quince and two clonal pear rootstocks have been placed on growers' farms for a test of their economic value.

Plums.—Czar was the only variety which yielded any crop after the May frosts. The opportunity has been taken to analyse the records of ten years' plum rootstock trials, and also to prepare a summary of the Station's experience on incompatibility in plums.

The first steps have been taken towards a trial of the effect of various varieties as stem builders on resistance to bacterial die-back in the susceptible variety Victoria. At the same time the trial will compare the effect of spraying and pruning methods on the incidence of the disease, and also the relation of the stem-builders to the vigour and cropping of the scion variety. A subsidiary trial will investigate the effect of cultural methods on die-back.

Peaches.—Preliminary studies have been carried out, and a nursery trial of Hale's Early budded on layered peach and myrobolan plum rootstocks has been set up.

Cherries.—The previously made observation that acid cherry scions bloom two or three days earlier on Mahaleb stocks than on Mazzards has been confirmed in 1935. A trial of Mazzard seedlings against seedlings from Pennsylvanian seed, both high and low worked, is being set up: the stocks to be high-worked will be grafted in the spring of 1936.

(b) *Propagation.*

The testing of new rootstocks for ease of propagation and the investigations of propagation technique have been continued. It appears as a result of the nursery technique studies that there is no difference between budded trees due to the presence or absence of wood in the bud-shield (20). The requirements of a reliable rubber budding-strip can now be outlined.

Top-grafting and frame-working of mature trees.—A number of old trees of Newton Wonder (a variety normally susceptible to disease after top-grafting) have been worked in various ways with Laxton's Superb. As regards growth made the results of various methods were in the order: oblique-cleft grafting, frame-working by stub-grafting, and rind-grafting. Many of the trees developed a "papery-bark" canker, and observations are being made as to any relation of the incidence of this disease to method of grafting adopted.

A preliminary experiment has been made, with promising results, on the application of stub-grafting to peaches and cherries.

(c) *Root Development.*

The observations on root growth of mature trees on stocks I, IX and XVI by means of glass-sided root observation trenches, have been continued. Improvements have been made in the trenches, including the repacking of the soil profile which had become rather loose.

The soil moisture meters devised by the Station have been further tested and are now on the market. They are being used in a controlled moisture experiment with strawberry and raspberry plants under glass, to investigate the effect of soil moisture on certain diseases.

During the grubbing of trial plots a number of apple trees of various types have had their root systems fully investigated and recorded (5).

(d) *Biennial bearing.*

Preliminary observations have been concluded, and a scheme of intensive experimentation is to be commenced.

(e) *Non-setting of pear blossom.*

Observations of the effect of various treatments and cultural practices have been continued. An intensive study is planned.

(f) *Pruning.*

Apples.—From the analysis of sixteen years' records on one plot it appears that certain general principles apply to all varieties, although in some respects varieties differ in their response to various treatments.

Pears.—The older pruning trial has now reached the stage where amount of blossom is little related to vegetative growth, and little difference is now found in crops under various treatments. A manurial trial is being superimposed on this plot. Other pruning trials are being continued.

Other fruits.—A trial to determine the relation between pruning and bacterial die-back in plums has been planted.

Definite results have been obtained from the trial of dehorning Morello cherries: these are to be checked by a further trial.

(g) *Manuring.*

Apples.—The trial of nitrogen, phosphate and potash on young trees was again marked by the effect of potash (and also of rootstock) on growth and foliage: the trees which have received no nitrogen also show a rather lighter green foliage.

The experiments on the restoration to health of unmanured trees and on the combined effect of grass and manuring, have been continued, with modifications to suit the state of the trees. A trial of Bramley's Seedling in grass, on which half had received no nitrogen, and half 5 cwt. nitro-chalk per acre, showed a striking difference in two years. The previously unmanured trees were then given 10 cwt. nitro-chalk per acre, as they were beginning to show serious effects, and by the summer there was little visual difference between the two series.

Other trials have been continued, including one on the time of application of nitrogen, and one comparing the effect of a single heavy dressing of nitro-chalk on Worcester Pearmains with that of moderate annual applications.

Pears.—A preliminary experiment on the potash and nitrogen requirements of pears has been started. It is proposed to use the data from this to plan a more comprehensive experiment.

Plums.—Trees of varieties of Damson on Myrobolan B have been planted with a view to studying the effect of different amounts of nitrogen on biennial bearing and delayed fruit ripening.

The pot culture experiment has been continued.

(h) *Varieties and classification.*

Observations and records on cordon trees of newer commercial varieties of apples and pears have been continued: also records on small fruit varieties. (7.)

Certain varieties of cherries continue to show an outstanding resistance to bacterial die-back. Buds of one of these varieties have been inserted in rootstocks in order to provide stems on which to " frame-work " the more susceptible varieties.

(i) *Breeding.*

Apple Rootstocks.—Work on the breeding of rootstocks immune to Woolly Aphis, undertaken in conjunction with the John Innes Horticultural Institution, is being continued; 574 seedlings of proved immunity are undergoing propagation tests, and a number of these have now reached a stage at which their influence on the scion can be judged. Several seem to be comparable with Malling IX. (8.)

A study of variations in leaf shape and petiole length in crosses between Malling IX and a wide variety of Paradise rootstocks revealed that the variations in these characters were only slightly greater in this range than those between leaves obtained from clonal races of the parent rootstocks. (4.)

Records on crosses between several pairs of Malling rootstocks, all worked with Lane's Prince Albert, are being taken.

Plum rootstocks.—New rootstocks now under test include a number of crosses between existing strains and also seedlings of *Prunus divaricata* collected in the Caucasus and Asia Minor.

Imported wildings.—Seedlings of apple, pear, and quince from seed collected in the Caucasus and Turkestan are being tested. The trials include one of the 300 quince seedlings with a number of pear scion varieties which are incompatible with all the quince rootstocks now in use.

Apple and pear scions.—A number of crosses between Northern Spy and dessert varieties have been made, in an attempt to produce an apple immune to Woolly Aphis. Certain other breeding experiments on apples and pears are also in progress.

Pollinations between Doyenne du Comice and other varieties have been carried out in an unsuccessful (owing to frost) study of the failure of this variety to set fruits.

Apples: shortening of juvenile period.—A further trial has confirmed the suggestion that working on a dwarfing and precocious rootstock produces earlier blossoming in seedlings. Another method that seems promising is working the scions on old rootstocks. Root restriction by growing in pots has not been successful so far.

(j) *Market qualities.*

The study of the influence of variety, cultural methods, etc., on market value of fruits marketed by different methods has been continued.

(k) *Soil types and plant performance.*

Survey on the Hastings beds.—This report is nearing completion. It has been found difficult to compare tree growth on various soil series owing to the masking effect of differences of variety, manuring, culture, etc. It is proposed to plant small plots of standard varieties to be treated in the same way on the various soils.

Survey of frost damage.—Following the severe frosts of May 1935 and the resulting damage, a survey was carried out to discover the causes underlying the inequality of damage in different plantations. It was found that in general land higher than its surroundings, and land near the sea or large rivers, was relatively little affected. Concerning the effect on susceptibility to frost of manuring and cultural differences no conclusion could be drawn; and the effects of wind-breaks were at first sight contradictory.

SPECIAL CROPS.

Walnuts.

Experiments have been made on the vegetative propagation of walnut stocks (Royal and Paradox), with encouraging results. At present the only rootstocks available are seedlings.

Methods of outdoor propagation of scions are being studied. Grafts are apt to dry out without uniting, but budding appears to be more successful.

A preliminary trial of seedling *Juglans nigra, regina* and *Californica* stocks is being carried out, and a more extended trial is projected.

Twelve selected varieties are now being grown-on by commercial firms for distribution, and should soon be available.

As regards diseases, it is now established that spraying with Bordeaux mixture will control bacterial blight. Graft disease, due to the fungus *Chalaropsis thielavioides,* can be avoided by sterilising the rootstocks with 1 per cent. formalin before grafting (5, 10).

Hops.

New varieties.—Records were taken of the crops on 178 varieties: samples of 78 were taken for analysis, and brewing trials conducted with 14. The merits of Brewers' Gold was again confirmed, and five new varieties were noted as of probable commercial value. This work is done in collaboration with the South-Eastern Agricultural College, Wye.

The new variety Brewers' Favourite and a new seedling are being grown-on for distribution.

Cultural trials.—Continued trials show that distance of planting has a greater effect on yield than numbers of bines per string, close planting giving better yields than wide planting.

A trial of three strains of Fuggles showed that they differed from each other in yield and in susceptibility to frost damage. Hard and light cutting treatments had no effect on cropping, possibly because of the frost damage.

SMALL FRUITS.

(For Raspberries, Strawberries, Blackberries, etc., see Sections VIII to X).

Currants.—Variety and cultural trials of black and red-currants have been continued, including trials of some new seedling varieties. Seedlings of hybrids between blackcurrant, *Ribes longeracemosum,* and gooseberry, have again proved completely sterile.

Gooseberries.—Clonal variety plots have been maintained, and fruit thinning trials continued.

II.—STATISTICS AND RECORDS.

Records.—Preparation of material for a report on apple rootstock trials has been the main task. The older records have been searched for information in connection with the extension of work on such projects as incompatibility and biennial bearing. The opportunity afforded by the light crop was taken to summarise certain extensive records, e.g., fruit size and colour.

Technique and planning.—Trials and improvement of sampling methods have been continued. The uniformity trial of strawberries has been terminated, and a number of other field trials with these and other crops planned.

III.—PLANT PHYSIOLOGY.

Analysis of growth relation of scion and stock.

A rapid method of recording summer growth in trees has been devised, in which each growth is classified into one of a small number of categories on the basis of obvious characters, and a map is made of the tree in which the category of each individual growth is indicated. By making such maps at intervals during the growing season growth can be followed throughout the year and in successive years. This method has been shown to reveal growth responses undetectable by other methods.

The investigations on the seasonal course of root and shoot development have been continued. Work has been commenced on relative assimilation rates of apple leaves of different ages and in different positions on various stock-scion combinations.

Vegetative propagation.

The experiment on pear root cuttings is being continued: it appears better not to remove the leaves from cuttings before planting. The effect of warming the cutting bed with hot water pipes is being tried.

IV.—BIOCHEMISTRY.

Mutual influence of stock and scion.

Technique.—Progress has been made towards overcoming the difficulties attendant on polarographic and spectrographic analysis of tree tissues.

Tree injection methods.—Methods for injecting separately parts of trees, and even parts of leaves, have been perfected. It was found in 1935 that the leaf symptoms, on which reliance was placed to avoid damage due to overdoses, were delayed for as long as a week in the early part of the season: the delay became progressively shorter until by midsummer the appearance of symptoms was normal. Probably this state of affairs was related to the May frosts.

Results of injection.—Injection of artificial manures during the first flush of growth gave marked increase in growth, but later injections had little effect. (21.)

When trees were injected with equal amounts of nitrogen as ammonium nitrate, urea and asparagin, respectively, it was found that the fruit differed both in total nitrogen content and in the form in which nitrogen was present.

The injection of nutrients and of the disinfectant 8-hydroxyquinoline potassium sulphate, together or separately, into plum trees affected by silver leaf has given promising results.

Injection of insecticides against woolly aphis is dealt with in Section VI.

V.—PLANT PATHOLOGY, MYCOLOGY AND BACTERIOLOGY.

Pathology of top fruits.

Crown-gall.—The value of organic mercurials applied to stocks when planted in the nursery, as a preventative of crown-gall, is being studied.

Analysis of the data from the second experiment on the susceptibility of apple stocks has shown a marked difference in vigour between parallel series of VII rootstocks inoculated or uninoculated with *Bacterium tumefaciens* whether galls had developed on the former series or not. This suggests that the pathogen may be active in the absence of galls. To test this an extensive trial has been commenced, with four varieties of rootstocks of differing susceptibility, and two strains of crown-gall organism.

Brown rot.—A wilt of plum shoots in nursery beds has been shown to be due to infection with *Sclerotinia laxa* (25). A rot of plums in cold storage is caused mainly by *S. fructigena* (27).

Silver leaf.—A "papery bark" canker of grafted apple trees has been investigated: the condition is sometimes associated with silvering of the neighbouring leaves, and it is suspected that the silver leaf fungus, *Stereum purpureum*, may be responsible.

(For injection experiments see Section IV.)

Bacterial diseases of fruit trees.—Experiments in pots and in the field on the effect of cultural conditions on the incidence of bacterial canker in plum trees have been continued. It has been observed that trees grown without phosphate resisted infection by direct inoculation with *Pseudomonas mors-prunorum*.

The study of bacteriosis of cherries and comparison of the causal organisms with those responsible for plum canker and shoot-wilt has been continued. An organism isolated from an outbreak of leaf spot and blossom blight on acid cherries appears to be different from the two known to cause bacteriosis in plums.

A number of bactericides have been tested *in vitro* against *Ps. mors-prunorum* and some good results obtained (28).

Spraying experiments on the control of bacterial canker and leaf-spot in cherries with Bordeaux mixture have been started.

Pathology of small fruits.

A non-parasitic raspberry disease, described in previous reports as die-back or black root-rot, occurred in many localities in the spring of 1935. An experiment on the possible relation between this disease and soil moisture conditions has been commenced.

See also Sections VIII to X.

Miscellaneous.

After a survey of further outbreaks of *Verticillium* wilt of hops in 1935, experiments have been started on the possibility of control by improved drainage and by the use of resistant varieties.

Walnut graft disease (caused by the fungus *Chalaropsis thielavioides*) has been described (13) and it has been shown that disinfection of greenhouses and of plants before grafting, with 1 per cent. formalin will control the disease.

VI.—ENTOMOLOGY.

Red spider.

Application of the results of a preliminary investigation of hop red spider has given control of the mite in the commercial hop garden.

Woolly aphis.

Observations on life history in relation to control measures have been continued (34). Studies of control in the nursery by dipping and fumigating of stocks, and by soil insecticides, were made. Field spraying trials were continued, and promising results were obtained in an attempt to control the insect by tree injection. Testing of resistant seedlings and stocks raised by the John Innes Horticultural Institution and the Belgian state horticulture school respectively, has also been continued.

Use of impregnated cardboard tree bands.

The promising results in control of weevil and Codling moth by this method obtained last year were confirmed, and the trees show no damage (35, 37). A new treatment against Codling moth—β-naphthol—has given good effects.

Mites.

Systematic studies of gall-mites and Tarsonemid mites have been continued . (See also Sections VIII and IX.)

VII.—INSECTICIDES AND FUNGICIDES.

Laboratory investigations.

Testing methods.—Endeavours to evolve standardised methods for the testing of insecticides and of fungicides are continuing. Progress has been made as regards ovicides and contact insecticides, and a method for fungicides has been produced but not yet perfected (39).

Ovicides and contact insecticides.—The ovicidal properties of low temperature carbonisation tar oils are being examined, with the co-operation of the Fuel Research Station, Greenwich. Certain materials of industrial origin have also been tested.

An investigation of the value of certain thiocyanates, nicotine derivatives, and chlorinated naphthalenes as contact insecticides has been started. More extensive tests of monochlornaphthalene are to be carried out.

Work on the correlation of the chemical properties of derris with its toxicity are being continued in conjunction with Rothamsted.

Chemical problems.—Preliminary experiments have been carried out on the relation of chemical constitution with insecticidal action.

Modification of routine field control methods.

Cox's Orange Pippin.—In 1934 two pre-blossom lime-sulphur sprays were again found to be more efficacious than one. Three spreaders—sulphite lye, sulphonated lorol, and a proprietary—seemed equal in value. Nicotine included at petal-fall gave good control of Apple Sawfly eggs (38).

In 1935 the scanty crop caused results to be poor. Two pre-blossom sprays were better than one, and lime-sulphur without a spreader was slightly more efficacious than with two of the spreaders tried. Lime-sulphur with emulsified petroleum oil caused severe defoliation.

Spreader trials.—A trial of seven spreaders and "no spreader" with lime sulphur against apple scab was ruined by the frost. As far as could be seen there was no significant difference between treatments.

Mitigation of spray damage.—The crop (Cox's and Worcesters) on the trial of the effect of ferrous sulphate in reducing damage by lime-sulphur, with or without arsenate, was ruined by frost. It was sufficiently clear, however, that ferrous sulphate did in fact prevent leaf-drop after spraying, while not impairing the fungicidal or acaricidal value of the spray.

A small trial was carried out on the possibility of reducing damage by using sprays more dilute than in present practice. A 2:3:100 Bordeaux mixture or a 1 per cent. lime-sulphur, each applied three times, gave good control of scab, but caused some defoliation towards the end of June. The spreaders tested did not affect the control obtained.

Field tests of new spray materials.

A number of spray materials, mostly obtained from commercial sources, were tested for phytocidal properties by a new single-branch technique. A few of these were selected for further trial. The substances similarly selected from trials in 1934 were tested more extensively in a statistically-planned field trial against scab. None of them was as good as lime-sulphur or Bordeaux.

Other investigations.

Codling moth.—Observations on the habits of this pest under local conditions, in relation to control measures, were made. No spraying trials were done on apples, but there was one successful trial on pears.

Field control of specific diseases.—Bordeaux mixture and lime-sulphur, each with and without a spreader, were tried against brown rot of Morello cherries: one application of the spray, just pre-blossom, was made. Final results are not available, but the lime-sulphur was found to burn leaves and flower-clusters.

Lime-sulphur spraying was found to check strawberry mildew better than sulphur dusting, when used on already diseased plants.

A comparison was made of autumn, spring, and autumn and spring, spraying with Bordeaux mixture against bacterial " shot-hole " and cankers of stone fruits. Autumn spraying caused a slight reduction in number of new cankers, while pre-blossom spraying reduced the amount of " shot-hole ".

Factors affecting susceptibility to disease.—" Branch-blister " disease of apples, which is becoming serious in Essex, appears to be affected by soil-type and weather, and this relation is being investigated. Records show that Cox's Orange Pippin at East Malling is more affected on No. IX stock than on I, V or XII, and that trees lacking potash were more severely affected than those receiving potash. Although the disease is probably not fungal, inoculations of trees in conditions favouring attack with fungi associated with the disease are being done.

VIII.—RASPBERRIES.

Variety trials.—A few new varieties, mainly American, have been added to the collection. A few varieties never grown in England free from mosaic are believed to have been grown uninfected in New Zealand. Owing to the effects of mosaic, the identity of at least one of these varieties in the healthy state is in doubt.

Breeding.—Thirteen years' work have given preliminary results and provided improved methods. The best results have been obtained by crossing selected "selfed" seedlings of different parentage (19).

Mosaic diseases.—The raspberry disease situation in Eastern Canada and U.S.A. has been summarised (29). Analysis of symptoms by grafting methods has been especially directed to the comparison of diseases in England and America, and the study of a mosaic on the highly resistant Red Cross variety.

The work of the station and extension nurseries in propagating disease-free canes for distribution has been maintained with continued success.

Experiments to determine whether the aphis *Amphorophora rubi* is a vector of mosaic have been continued.

IX.—STRAWBERRIES.

Breeding.—Crossing of commercial varieties in an endeavour to obtain commercially valuable disease-resistant seedlings has been continued. Experiments made to determine whether susceptibility to Yellow Edge disease is inherited seem to suggest that susceptibility is in fact inherited.

A number of seedlings from the Horticultural Research Station, Cambridge, mainly crosses between British and American varieties, were tested and found very susceptible to disease.

Propagation.—Progress continued in the propagation of a virus-free clone of Royal Sovereign: the effects of a late spread of Yellow Edge were minimised by the method of isolation of runners adopted. The runners are to be kept under observation for a further year before releasing in quantity. Virus-free clones of other varieties are now being raised and multiplied.

The study of behaviour of 2,000 plants of certain clonal families over five years has now been concluded. The records have not yet been analysed, but it appears that the position on the parent stolon and time of formation have little effect on the development of a plant provided it becomes established. Small late-formed runners are more unlikely to establish themselves than others.

A trial of runners from one- and two-year old parents, spaced and unspaced, will crop for the first time in 1936. In 1935 no difference in vigour or blossoming was visible.

Planting.—Hot water treated and untreated runners were planted every month, September 1934-April 1935. Results showed that the earlier that untreated runners are planted, the more vigorously they grow. With treated runners, early autumn planting was best, then spring planting. Warm water treatment seems to cause a check in root development which lasts about three weeks in autumn, longer in winter, and rather less in spring. The trial is being repeated: next year part of it will be on land previously under strawberries and part on fresh land.

" Burning " and pest control.—It has been found that burning of straw litter after picking will control completely aphids, leaf hoppers, white fly and red spider; but tarsonemid mites are only temporarily checked. In 1935 the " burnt " plants were slightly smaller than the unburnt, but their crop was more than double: this may be due partly to a difference in the effect of the May frosts, and the experiment will be repeated.

A test of " burning " unlittered strawberry plants by the use of a motor-driven oil blow-lamp did not suggest that the method was practicable.

Manuring.—A trial for the relation of growth and cropping to soil fertility and distance of planting has been prepared.

Virus diseases.—Information regarding the field diagnosis of these diseases on Royal Sovereign has been published (18). Field experiments on the relation of symptoms and severity of attack to cultural conditions after infection, and to the seasonal cycle and local fluctuations of weather, are yielding positive results.

Attempts were made to transmit " yellow edge " and " crinkle " to a number of varieties and species other than Royal Sovereign, and the symptoms produced were studied. This trial included some hardy hybrid seedlings from the John Innes Horticultural Institution which showed a marked absence of " yellow edge " symptoms.

Attempts have been made to infect with " yellow edge " the wild strawberry (*Fragaria vesca*) and *Potentilla* spp., all known to be alternative hosts of the strawberry aphis.

An attempt to identify cases of " crinkle " in collections of seedlings at East Malling has been carried out, together with a study of the possible relation of " crinkle " to " yellow edge" and the diagnosis of one or both in a plant. Results indicate that "crinkle" in the East Malling area is by no means restricted to the above collections of seedlings.

Strawberry root-rot.—Isolation and inoculation have shown that five fungi attack strawberry roots—*Coniothyrium Fuckelii, Hainesia Lythri, Cylindrocarpon radicicola, Fusarium orthoceras* and *Pachybasium candidum* (23). Confusion may have been caused in the past by the browning of normal cortical tissues, which may resemble fungal lesions.

Strawberry tarsonemid mite.—A study of the life-cycle has been made, with particular reference to alternative hosts, and to migration under field conditions. It is found that healthy plants within 30 yards of mite-infected plants may be attacked.

Previous experiments have furnished no evidence that this mite can transmit "yellow-edge," but a further trial is in progress. Spray trials against the mite have been continued, together with a search for any natural enemies.

Strawberry aphis.—Studies of the life-cycle have been continued, including an enumeration of alternative hosts, and a determination of the months of the year during which the aphis carries "yellow-edge" (33). As regards control, dusts have so far been found ineffective, but certain sprays will wipe out the insect under field conditions.

Miscellaneous.—Several insects feeding on the strawberry plant are being studied as possible vectors of "yellow-edge."

Investigations of the technique of the warm water treatment of runners are continuing.

X.—LOGANBERRIES, BLACKBERRIES AND DEWBERRIES.

Nomenclature and varieties.—A new variety collection of blackberries and dewberries has been planted, including some recent hybrids for comparison with standard varieties. Some blackberry seedlings from the John Innes Horticultural Institution have been planted for field trial.

Propagation, etc.—Clonal stool-beds of loganberries and blackberries are now well-established, and propagation trials of several varieties will be commenced in 1936.

A plot for the comparison of loganberry with phenomenal berry has been planted: this will be also used for spraying trials on cane-spot disease.

Loganberry cane-spot.—A trial of the efficiency of a combined fungicide (lime-sulphur or a colloidal copper compound) and derris wash applied at the time for beetle control has again been made. Records were taken of amount and persistence of deposit, and of amount of fungal spotting.

Blackberry mites.—A trial of Himalaya and Black Diamond berries is also being used to determine whether an Eriophyid mite is associated with the American " red berry disease " of Rubi. The plants will also be used later for a spraying experiment.

Titles of papers issued during the year.

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2. *Supplementary Annual Report.* General Development and Activities. 1934. May, 1935.

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6. Bane, W. A., Beard, F. H., and De Wet, A. F.: A comparison of the root systems of mature trees of Bramley's Seedling and Worcester Pearmain on various rootstocks. *Ibid.,* 90-99, May, 1935.
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9. Edgar, J. L., and De Wet, A. F.: An experiment in sampling technique for size and colour of apples. (Bramley's Seedling on rootstock No. II. 1934 Crop.) *Ibid.,* 130-134, May, 1935.
10. Hamond, J. B.: The future of walnut propagation in England. *Ibid.,* 239-241, May, 1935.
11. Hatton, R. G.: Rootstocks for pears. *R. Hort. Soc. Report on Apples and Pears—Varieties and Cultivation,* 1934. 154-166, 1935 and *E. Malling Res. Sta. Ann. Rep.,* 1934, 75-86, May, 1935.
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13. Hamond, J. B.: The morphology, physiology and mode of parasitism of a species of Chalaropsis infecting nursery walnut trees. *J. Pomol. and Hort. Sci.,* **13,** 81-107, 1935.
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15. ———: Soil factors in relation to root growth. *Trans. 3rd Inter. Cong. Soil Sci.,* **1,** 249-253, 1935.
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21. Roach, W. A.: Tree injection. Invigoration by the injection of fertilizers. A progress report. *Ibid.*, 135-138, May, 1935.
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42. Thomas, F. J. D.: Preliminary experiments on the control of apple surface-eating tortricid larvae. *Ibid.*, 205-207, May, 1935.

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MISCELLANEOUS.

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15. HORTICULTURAL RESEARCH STATION, CAMBRIDGE UNIVERSITY

PLANT BREEDING

Work has been continued on the lines indicated in the last report; it has, however, been hampered by three successive years of drought. Since most of the work is carried out under commercial conditions and on a fairly large scale at a distance from the Station, no methods of coping with drought conditions are feasible. At the Station a plentiful supply of water could be obtained from the greensand which here lies at a depth of about 120 feet. In order to avoid the loss or wastage of useful breeding material year after year it will be necessary to consider the question of ensuring a supply of water during dry periods (which even in a normal year usually occur when water is most needed by vegetables).

Distribution of seed to growers.—In spite of very adverse weather conditions and the unusual activity of pests and diseases this year, a fair quantity of Brussels sprout seed has been harvested in Norfolk and Suffolk. In Bedfordshire the amount harvested was unfortunately negligible. This was also the case with Roscoff broccoli seed at Hayling Island.

It is proposed to distribute seed in Norfolk and Suffolk during 1936.

During 1936 arrangements will be made for growing seed of Brussels sprouts, hardy broccoli, and cauliflower on a more extensive scale than was possible in 1935. It is hoped that a centre or centres will be found where all the seed needed by East Anglian growers can be produced.

Broccoli.—Work with Roscoff and late hardy types has been continued. Seed of these types may be available for trials in 1937.

In the case of Roscoff broccoli, our material is being grown this year at Beaulieu and at Hayling Island. The hardy types are grown at the Station where conditions are such that only plants of iron constitution can survive.

Brussels sprouts.—Material has been grown on an extensive scale, with the co-operation of growers, in Cambridgeshire (Lolworth), Bedfordshire (Langford and Maulden), Suffolk (Shippea Hill and Troston), Hertfordshire (Oaklands). In addition, about 30,000 plants of one of our stocks were supplied for the Provincial Manuring experiments.

Only one of the trials can, however, be regarded as a complete success: that at Shippea Hill, where dry weather has little effect on plant growth. All the other centres have felt the drought severely. Nevertheless, ample material will be available for further breeding work and for seed production, except in West Suffolk where conditions have been particularly unfavourable for sprout growing.

A type of sprout has been evolved which we are assured is ideal for canning and for the trade in small " boxed " sprouts. This type is in addition unaffected by conditions which cause Brussels sprouts of ordinary type to " blow " (i.e. to produce loosely wrapped and therefore unsaleable axillary buds).

Selfed seed has been obtained from selected " basic types " of sprout plants, both from the main stem racemes and from sprout branches.

Some preliminary experiments were made on the length of time for which the stigma remains receptive.

Cauliflowers.—Two types of early cauliflower bred at the Station have been further tested and a supply of seed has been obtained from each of them. It is proposed to call the attention of Organisers to these stocks with the object of eventually distributing seed of them to growers.

Onions.—After a period of years during which onions have been regarded as no longer an important crop and during which the varieties bred at the Station have only been maintained as nucleus stocks, a sudden revival of interest was manifested in this vegetable and requests for seed for distribution to growers were received. It was impossible to comply with these requests. If, however, interest is maintained, an effort will be made to produce seed in quantity and a method of distribution similar to that adopted in the case of brussels sprouts will be evolved.

Genetical work has been continued to test a hypothesis of factors governing susceptibility to *Botrytis allii.*

Peas.—Trials were made of various stocks bred at the Station. Three of these stocks are now considered to be fixed and will be tested against commercial varieties next year.

Dwarf strains are being developed as possibilities for field culture.

The F_1 plants of crosses with multi-podded varieties have been examined and recorded for future work.

CHEMISTRY.

Investigations on the physico-chemical properties of spray fluids were continued (1, 2, 3 and 4). In conjunction with Professor Engledow, successful preliminary experiments on the control of lawn weeds by ammonium sulphate solutions to which a spreader had been added were made.

A number of determinations of the pH values of soils was made for mycological purposes. The work on attractants for cabbage root fly has now been discontinued. Yeast has been found to be the most successful attractant examined.

The experiments on water losses of onions occurring during storage have been concluded, and the data obtained are being subjected to examination with a view to publication.

Manurial plots have been laid down in an attempt to investigate the specific effects of nitrogen, potassium, and phosphorus on the character and growth of brussels sprouts, peas, summer lettuce, spring cabbage, and carrots, grown on the plots in this rotation. No differences have been obtained in the first year of experiment, probably because the plots are situated on freshly turned-in pasture.

The fitting-up and equipment of a field laboratory and greenhouse to be devoted to pot culture experiments on vegetables have been supervised. Pot culture experiments with lettuce will be commenced soon.

MYCOLOGY.

With reference to the programme for 1934, it is to be noted that work on ring-spot of lettuce has been substituted for that on strawberry diseases.

Club-root of brassicae.—The experiments mentioned below are inter-related as far as possible and the grouping is therefore somewhat arbitrary. When no results are given the experiments are still in progress or the figures obtained have not yet been analysed. To avoid repetition it may be stated here that the results of single experiments on this disease are not regarded as reliable; many of the experiments described below will therefore be repeated.

(a) *Experiments concerning the periodic nature of infection, including consideration both of the fungus and of the host-plant*:

(i) An experiment in which the infection resulting from a given sample of " club " was followed throughout the year.

The results seem to confirm the existence of an optimum period for infection in the early summer, not entirely dependent upon temperature. The age of the spores seems also to be important.

(ii) Experiments to examine the effect of the age of the spores on the infection produced.

(iii) An experiment to determine what percentage of plants become infected in the first 24 hours, 48 hours, etc., after planting.

The majority of the plants became infected within 24 hours.

(b) *Experiments concerning the treatment of club-root by chemical means*:

(i) Experiments comparing the effects of mercuric chloride, various organic mercury compounds, cuprous oxide, zinc hydroxide, calcium hydroxide, magnesium hydroxide, bleaching powder, carbide waste, etc.

(ii) Experiments to determine the relative effects of applying a given chemical treatment at varying periods before planting. This was done at more than one period of the year; the treatments used were mercuric chloride (in greenhouse experiments) and a proprietary mixture (in the field).

(iii) An attempt to analyse the effect of lime—to discover the parts played by calcium as such and by pH. Similar experiments were also carried out with compounds of magnesium.

(iv) Comparison of the action of mercuric chloride in the presence and absence of small quantities of calcium.

(v) Experiment on the effect of calcium carbonate on club-root in the presence and absence of stable manure.

The results differed somewhat from those of Potts (Trans. Brit. Mycol. Soc. 19, Part II, 1935) notably in the relatively small effect produced by the stable manure.

(vi) Continuation and extension of the field chemical trials at Cross Hall, St. Neots.

(c) *Experiments concerning the effect of environmental conditions on infection.*—An experiment to determine the effects of short periods of high soil moisture just before, at, and soon after planting.

The results suggested that the state of the plant at the time when conditions were optimum for the fungus was the dominating factor. A single short period of high soil moisture only resulted in heavy infection when the plants were in a half-wilted state at that time.

(d) *Experiment on varietal resistance.*—The relatively "tolerant" strain of Brussels sprout mentioned in previous reports was grown alongside a susceptible variety in infected land at St. Neots.

There seemed to be little difference between the two varieties in the earlier stages of growth; both became infected about the same time and to approximately the same extent.

(e) *Experiments to examine the influence of chemicals* (*used against club-root*) *on the incidence of Scab on a following potato crop.*—Trials have been carried out at Roxton (Beds.), St. Neots, and Cambridge.

(f) *Miscellaneous.*—Various experiments, which so far have yielded no results, are not mentioned above. They include further experiments on the effects of temperature and soil-moisture and an attempt to estimate the relative susceptibility of different Brassica varieties by the injection of non-living extracts of *Plasmodiophora brassicae.* The 1934 experiments showed that black mustard was only partially resistant and that mustard oil and a dug-in black mustard crop did not control the disease.

Ring-spot of lettuce (Marssonina panattoniana).—The work has been concerned mainly with developing a satisfactory technique for infection experiments; such factors as the relative efficiency of aerial and soil infection under various temperature conditions have been investigated.

Evidence has been obtained which suggests that the disease can be seed-borne, but that the percentage of diseased seeds is usually very low. Infected seed may, however, be of primary importance economically, since a single diseased plant can serve as a centre for the spread of infection in the field.

Plot experiments on soil treatment, seed treatment and the spraying of young plants were carried out, but failed to yield satisfactory results. This was because of the very small amount of disease present, due probably to the abnormally hot and dry summer. Similar experiments with winter lettuce are in progress.

ENTOMOLOGY.

Certain lines of work formerly carried out at the Station have been continued by the Advisory Entomologist at Cambridge.

Titles of papers issued during the year.

1. Woodman, R. M.: Studies in emulsions. II. Proteins and allied substances as emulsifiers for organic bases. *J. Soc. Chem. Ind.*, **53,** 115T, 1934.
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16. EXPERIMENTAL AND RESEARCH STATION, CHESHUNT

MANURIAL AND CROP MANAGEMENT TRIALS.

Tomatoes.

The improvement of glasshouse soils by placing clean straw in the soil to a depth of 20 ins. so that the haulms are in a vertical position was tested further, by applying this material during the process of sterilising the soil with steam. Although an increased yield was obtained during the first year after treatment it is expected that the chief benefit will be experienced during the second and later years.

An important new treatment for the purpose of improving root development of tomatoes and also a means for combating root rot has been discovered. This consists firstly of preventing the foliage from wilting by closing all ventilators, shading the glass and maintaining a moist atmosphere through overhead damping, and secondly of covering the soil with a layer of good peat. If this is kept continually moist by damping with water, new roots are produced freely from the bases of the stems and within a fortnight new root growth is so extensive that the foliage does not wilt when the ventilators are fully open.

This process is being tested in nurseries in different parts of the country and should prove of great value both as a means of increasing the crop and of improving the quality of the fruit.

The effect of applying hoof and horn meal to steam sterilized soil before planting was tested. Although it did not affect the weight of crop produced, it increased the amount of blotchy ripening and softness and is to be avoided.

The effect of omitting phosphate from steamed soil was also investigated and as in the past no harmful result was observed either in regard to crop weight or quality.

Variety trials were continued as in the past, testing new varieties against those of proved value in commercial work.

The work on varieties resistant to *Cladosporium fulvum* which causes leaf mould of the tomato was continued. The types raised many years ago by crossing the resistant but poor cropping types, Stirling Castle and Up-to-date, with standard varieties such as E.S.I. have shown marked resistance, and considerable improvement in shape and general appearance but the crop produced is not sufficiently heavy for commercial work. In 1933, they were again crossed with standard types. The F_2 generations grown in 1935 show considerable promise, for the fruit is larger and the crop heavier than in past years.

The work in connection with soil warming was continued and once again heavier crops of good quality tomatoes were obtained.

Special attention has been given to the quality of the tomatoes grown in the different experimental plots.

In general, the quality during the hottest parts of the year was better from the houses planted in late February than from those planted earlier. The quality was also good in the soil warming experiments and when a top dressing of peat was applied.

Cucumbers.

The cucumber experiments were chiefly concerned with the effect of supplying artificial light during the time the plants remained in the propagating houses. Approximately six hours extra illumination each day was applied to different batches of plants, the light being obtained either from 500-watt gas-filled electric lamps or from Neon discharge tubes. Excellent results were obtained during the propagation stages, the treated plants being more robust and more highly developed than the untreated controls. The treated plants fruited ten days earlier than the controls and realised high prices in the market during that period. The total crop, however, was not increased.

The soil warming experiments with cucumbers were continued. Once again the crop was increased considerably, root development was accelerated and the plants retained their vigour until the end of the season, by which time the control beds were finished.

An attempt has been made to improve the type of cucumber at present available by raising a variety with a short neck. Although it is too early to draw any definite conclusions, the present results are promising.

Lettuce.

Cheshunt Early Giant lettuce continues to be a valuable variety for autumn and winter work. Seeds have been distributed to nurserymen in different parts of the country and their reports will be awaited with interest.

The cultivation of salad crops in cold frames has been continued.

The importance of the correct physical state of the soil has been amply proved, and beneficial results have been obtained by mixing peat or spent mushroom beds with the soil.

The ventilation of frames has been studied and better results have been obtained by keeping the lights closed until the lettuce crop is ready for market, except after frost, than by ventilating the frames during favourable weather.

The Iron Fireman type of automatic stoker has been tested and proved satisfactory for a number of years. A second type, the Mastoker has now been installed.

A draught regulator and fuel economiser has also been installed. This has proved a most valuable means of controlling the rate and uniformity of combustion.

Pests and Diseases.

A good deal of work has been devoted to a study of the bionomics of *Thrips tabaci,* Lind. in relation to the carnation, and *T. fuscipennis,* Hal. to the rose under glass. Experiments in the control of these two serious pests have also been undertaken.

It has been established that *T. tabaci* lays its eggs principally in the sepals of the carnation bloom shortly before the latter opens, less often in the petals shortly after opening of the calyx. The larvae escape from the blooms when they are full-fed, and pupate in the ground or in concealed places away from the plants. The two pupal stages are resistant to external conditions, as they will pass through these transformations and become adult while floating upon water.

It is therefore probable that numbers of the insects are distributed to nurseries in returnable market boxes. Series of plants have been dusted at intervals of 3, 7 and 14 days with Pyrethrum, but infestation of the flowers has not been reduced by this method. Repeated applications of naphthalene also had little effect in preventing oviposition, but a naphthalene fumigation completely ridded the experimental house of the insect.

T. fuscipennis Hal. has been found to breed upon the young foliage of roses as well as in the opening blooms. Repeated applications of Pyrethrum dust did not reduce the infestation and made the foliage of the plants very dirty. Application of naphthalene to the plants did not lessen the infestation. Poison-bait trials showed that the insects were attracted to solutions of brown sugar, rather than to those of white sugar or treacle. The insects were poisoned by brown sugar bait containing sodium fluoride, but the minimum quantity of poison necessary has not yet been determined, as the experiments were seriously interfered with by the presence of a predatory bug, as yet unidentified but probably belonging to the genus *Triphleps.* This predatory was accidentally brought into the experimental house upon blooms from outside. A bait containing brown sugar and sodium fluoride was applied to a few plants upon an infected nursery, but the foliage of the plants sprayed was seriously injured by it.

The substitution of derris insecticides for petroleum oil emulsions as a control of red-spider mite on young tomato plants has been investigated. Control has been obtained early in the season by repeated applications of derris extract and derris powder sprays. The use of dusts containing derris did not yield satisfactory results.

Further trials of oil soluble fungicides have resulted in damage to tomato and cucumber foliage when fungicidal concentrations were employed. Several oil soluble mercury compounds showed high fungicidal value when tested against tomato mildew and rose rust. The damage to plants resulting from the application of oil emulsions and salicylanilide sprays within a period of ten days of one another has been traced to the slight solubility of salicylanilide in petroleum and the penetration of the tissues by the oil solution.

The suitability of many samples of copper oxychloride, for use with an oil emulsion as a combined insecticide-fungicide spray on tomatoes and cucumbers, has been investigated. None of these samples yielded results as good as that obtained with a proprietary copper oxychloride suspension together with the oil emulsion.

The methods advised for the control of red-spider mite on carnations have been re-investigated and the use of high temperatures over long periods proved unnecessary. Consequently it should be possible to combat this pest without detrimental effect to the plants.

Experiments have also been conducted with new fungicides against " damping off " of tomato seedlings and in the control of rose rust and rose mildew.

Comparative tests have been made with mixtures which evolve hydrogen cyanide in the presence of moisture owing to the advantages they possess over the jar method of cyaniding where sodium cyanide and sulphuric acid are used.

The investigation of the rust disease of the rose has been continued. Comparative inoculations of the rose, of *Rosa laxa* and of various varieties of *R. canina* have been made with strains of rust occurring on the rose and various briars. The form derived from the rose has not infected any of the briars tested except " Schmidts Special." Of the forms occurring on briars only one (from *R. laxa*) has proved capable of infecting the rose. The strains taken from briars show some differences among themselves in their capacity to infect the briars tested. It is, however, impossible to find any significant differences in the size of the teleutospores when growing on the same host variety. They are therefore probably strains of the same species. The rose strains may possibly be a distinct species since the teleutospores are considerably larger, but this could be due to the effect of the host and not to a difference in species.

Germination studies with teleutospores on the rose have shown that exposure to winter cold and damp is necessary for the proper maturing of the spores. Only spores so exposed germinated and then only during a short period in May. Attempts to infect plants with rust by means of the teleutospores during this period were unsuccessful.

The fungus reported last year as causing a wilt disease of cultivated heaths, *Erica hyemalis, E. nivalis* and *E. Willmoreana* has been identified as *Phytophthora cinnamomi.* The source of infection has been traced to the water supply and standing out ground, and control measures have been recommended.

Plants suffering, or suspected of suffering, from virus diseases continue to be received for examination, and during 1935 several diseases either new to the country or not previously recorded at Cheshunt were investigated. These include two new diseases of the tomato (it is proposed to call one " Bushy Stunt " and the other is a disease characterised by the " fernleaf " type of symptom, but the causal virus is distinct from cucumber virus 1), and mosaic diseases of fig and watercress.

An investigation of the effect of tomato mosaic virus on the growth of seedling tomato plants was completed.

The work on lettuce diseases has been continued in relation to attack by *Bremia lactucae* and another disease with which the presence of bacteria is associated.

The investigation of Crown Rot in rhubarb has not disclosed any relationship between this disease and manurial treatment, but the extent of crown rot appears to be connected with the time of planting. Exposure of the plants for several weeks before planting increases susceptibility to infection.

Investigations of the *Verticillium* wilt disease of carnations have been continued. Further evidence that the disease is transmitted from crop to crop in the cuttings has been obtained. A surprising result has been failure to infect Asters as these plants are reputed elsewhere to be susceptible.

Attempts to infect chrysanthemums have also been unsuccessful and this crop may prove to be of value in replacing carnations in badly diseased soil. Carnation diseases caused by *Rhizoctonia* and various species of *Fusarium* have also been investigated. The number of inquiries from growers concerning carnation diseases reveals an urgent need for the erection of a carnation house where control measures can be tested systematically.

OTHER INVESTIGATIONS.

The physiological studies on tomato seedlings variety E.S.1 having eight or nine leaves have been continued.

An estimate has been made of the total light energy falling on the plants during the period of growth from seed to eight leaves. Two important results have been obtained. The first result shows that there is a marked falling off in the photosynthetic efficiency (amount of dry matter produced per unit of light) as the light intensity and day length increase. The second result is to show that the so-called " seasonal " differences observed between seedlings grown from sowings made at different times of the year are, under ordinary cultural conditions, more closely related to light than to any other variable factor and further that the total amount of light falling on the seedling during its growth period is more important than the day length.

A preliminary study of the movement of assimilates in the plant has been carried out and it has been shown that, contrary to the usually accepted view, most of the assimilate is removed from the leaf system during the night, the greater part of the movement of assimilate from the leaf system to the stem occurs during the light period and that never more than 20 per cent., usually much less, of this movement occurs during the night. The most important change taking place in the plant during the night appears to be one in the water balance, although movement of assimilate from the stem to the root is shown to continue.

The percentage of assimilate which is passed from the leaves to the stem and root in 24 hours is shown to be at a minimum in summer and a maximum in winter, the winter maximum tending to throw the plant out of balance by the supply of a relatively large fraction of the assimilate to the root at the expense of the leaves.

A critical investigation of the movement of assimilate within the leaf system, i.e., from relatively mature leaves to embryonic leaves and flower buds, is in progress.

A new case of chlorate injury to chrysanthemums was investigated. It appears, also, that the winter cherry and dahlia are highly susceptible to chlorates, being almost as susceptible as tomato plants. Antirrhinums and heaths show a comparatively high resistance but broad bean, aster, nasturtium, cineraria and wallflower are all susceptible. In general it must be repeated that the greatest care should be taken in the use of chlorate weed killers.

Of a number of nitrogenous fertilisers analysed, one was offered at a price very considerably in excess of its manurial value.

The possibilities of treating water or soil to overcome the injurious effects of excess of salt have been explored but with no useful result.

A preliminary study showed that steaming has but little effect on the availability of phosphoric acid in the soil as determined by solubility in one per cent. citric acid. The availability of soil potash, however, appears to be definitely increased.

Titles of papers issued during the year.

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2. Ainsworth, G. C.: Virus disease of the cucumber. *Ibid.*, **42,** 4, 338-344, 1935.
3. ————: Berkeley, G. H., and Caldwell, J.: A comparison of English and Canadian tomato virus diseases. *Ann. Appl. Biol.*, **21,** 4, 566-580, 1934.
4. ————: A comparison of certain English and Canadian potato viruses found infecting tomatoes. *Ibid.*, **21,** 4, 581-587, 1934.
5. ————: Spotted wilt of Richardias (Arums). *Gard. Chron.*, **97,** 2507, 31, 1935.
6. ————: Mosaic diseases of cucumber. *Ann. Appl. Biol.*, **22,** 1, 55-67, 1935.
7. Bolas, B. D., and Melville, R.: The effect on the tomato plant of carbon dioxide produced by combustion. *Ibid.*, **22,** 1, 1-15, 1935.
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17. JOHN INNES HORTICULTURAL INSTITUTION, MERTON, LONDON

Genetical work.

Primula sinensis.—In the course of the experiments a number of F_2 families have been grown involving the striking orange mutant " Dazzler ", which was given to the Institution in 1933. In various combinations this " Dazzler " factor has an intensifying effect on flower colour, and produces shades which have not been seen before in *Primula sinensis*. Another factor extensively recombined was " Claw ", a mutant obtained at this Institution a few years ago, which has a profound effect upon the anatomy of the plant, especially of the leaf. The only new mutation which appeared is one which has been designated " Cyclamen ". This is characterised by a reflexed corolla (not known in *Primula* but characteristic of the allied genera, *Cyclamen* and *Dodecatheon*), and has appressed instead of patent hairs and some distortion of the peduncles. A further paper on linkage has been published(13).

Pisum sativum.—Work has been continued on the strains of peas showing partial sterility due to chromosome translocations.

The strains which appeared at Merton have been tested against other sterile strains discovered by Dr. Hakansson of Lund and Professor Winge of Copenhagen, and the relative positions of the translocations determined cytologically. The linkage work on *Pisum* has been continued.

Zea Mays.—Experiments have been continued on selective pollination in maize as revealed by the endosperm characters. A series of tests of earliness have also been started, with the object of obtaining early-maturing races suitable for growing for table purposes in England. Last year's results suggest that the plants are very sensitive to a check in growth, and if sown in pots should not be kept in them much more than a fortnight before planting out. In certain seasons the results from sowing the seed in the open at the end of May may be as good as those from raising plants in pots.

Nicotiana, Petunia and Antirrhinum.—Investigations of self-sterility in these species have been continued (1), together with a study of inheritance of rust-resistance in *Antirrhinum*. The genetics of "flaking" of the flower of *Antirrhinum* are also being studied.

Genetical experiments have been begun or continued on *Aquilegia vulgaris, Cheiranthus cheiri, Dahlia variabilis, Eschscholtzia californica, Freesia* sp., *Papaver nudicaule* and related spp., *Streptocarpus* spp., *Tropaeolum majus* and *Verbena hortensis,* in most cases correlated with pigmentation studies (see below).

Cytological work.

Cytological investigations have been continued on *Tulipa, Fritillaria, Paris, Trillium, Lycopersicum* (38), and various other plant species, and also on some animal species. A series of papers dealing with the mechanics of the chromosomes has been published (6-12). Cytological work in progress includes X-ray studies, particularly on the splitting of the chromosome thread, and work on Chromosome irregularities in *Crepis capillaris* (34, 35).

Biochemical work.

The investigations on the pigmentation of plants have been continued and extended, in conjunction with genetical and cytological studies (26). This branch of study is being applied to as many plants as can be handled, and extensive experiments have been made on *Primula sinensis, Lathyrus odoratus, Dahlia variabilis, Papaver* spp., *Streptocarpus* spp. and *Verbena hortensis.*

Mycology.

Investigations on the biology of the wild and cultivated species of Mushroom (*Psalliota* spp.) have been continued.

Physiology.

Physiological investigations on the effects of polyploidy have been carried out. Experiments on the relative vitamin C content of diploid and polyploid strains of tomato have been made by the Lister Institute, in collaboration with this Institution.

Sterilisation of soil.

As a result of a large series of experiments on the technique of soil sterilisation, it has been found desirable to sterilise the components of the potting mixtures separately. A sterilised soil compost with fertilisers, particularly phosphate, added, gave highly satisfactory results when used for raising seedlings indoors.

Fruit investigations.

A beginning has been made with pollination studies of cultivated pears to determine the extent of self-sterility and cross-incompatibility among the leading varieties (29, 30). One curious result has emerged. The variety "Conference" will set fruit when self-pollinated, but the fruits, both in their shape and their imperfect production of seeds, show that sexual union has been incomplete. If on the same tree some flowers are selfed and some cross-pollinated, only the latter develop, though the nutritional state of the tree was adequate to carry both sets of fruit to maturity. There was a preferential movement of the reserves to the crossed embryos.

Several triploids have already been discovered; their number bears about the same proportion to the diploids determined as exists between diploids and triploids in the apples. Though the pears agree with the apples in being secondary polyploids with a basic number of 17 chromosomes, which is itself a partial repetition, $7+7+3$, of the fundamental 7 of the Rose family, the constitution is different and remains a subject for further investigation.

Among the Rubi great cytological diversity exists. There are both diploid and tetraploid raspberries and blackberries; hybrid and derived forms exist, containing 2, 3, 4, 5, 6, 7 and 8 sets of chromosomes. Several of these are in commercial cultivation, the best-known being the hexaploid loganberry. Large families have been raised in this group both for the elucidation of the mode of inheritance and with the expectation of obtaining a variety of high polyploid vigour but of better quality than the loganberry. One of the older hybrids, a tetraploid blackberry of exceptional quality, has now been put on the market. From this variety has arisen a prickleless race of blackberries, of which large numbers have been raised, though of those which have as yet fruited, none have been picked out as fully satisfactory for market cultivation.

Titles of papers issued during the year.

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2. Collins, E. J.: The problem of immunity to wart disease [*Synchytrium endobioticum* (Schilb.) Perc.] in the potato. *Ann. Bot.*, **49,** 479-492, July, 1935.
3. Crane, M. B.: The origin of cultivated fruits and the raising of new varieties. *Roy. Hort. Soc. Conf. on apples and pears,* 1934, 90-97, June, 1935.
4. ———: The origin of the pink-flowered chestnut, *Aesculus* × *carnea. J. Roy. Hort. Soc.*, **60,** 171-174, 1935.
5. Crane, M. B., and Lawrence, W. J. C.: The genetics of garden plants. Macmillan, London, 1934.
6. Darlington, C. D.: Mechanical aspects of nuclear division. *J. Roy. Coll. Sci.*, **4,** 93-95, Nov., 1934.
7. ———: Chromosome mechanics. *Bull. Appl. Bot., II,* **6,** 1935.
8. ———: The old terminology and the new analysis of chromosome behaviour. *Ann. Bot.*, **49,** 579-586, July, 1935.
9. ———: The internal mechanics of the chromosomes. I. The nuclear cycle in *Fritillaria. Proc. Roy. Soc. B,* **118,** 33-59, July, 1935.
10. ———: *Ibid.*, II. Prophase pairing at meiosis in *Fritillaria. Ibid.*, **118,** 59-73, July, 1935.
11. ———: *Ibid.*, III. Relational coiling and crossing-over in *Fritillaria. Ibid.*, **118,** 74-96, July, 1935.
12. ———: The time, place and action of crossing-over. *J. Genet.*, **31,** 185-212, Aug., 1935.
13. De Winton, D., and Haldane, J. B. S.: The genetics of *Primula sinensis.* III. Linkage in the diploid. *Ibid.*, **31,** 67-100, June, 1935.
14. Fabergé, A. C.: Tetraploid sweet peas. *Nature,* **135,** 876, May, 1935.
15. Haldane, J. B. S.: A mathematical theory of natural and artificial selection. X. Some theorems on artificial selection. *Genetics*, **19,** 412-429, Sept., 1934.
16. ———: Methods for the detection of autosomal linkage in man. *Ann. Eugen.*, **6,** 26-65, 1934.
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18. ———: Some problems of mathematical biology. *J. Math. & Phys.* **14,** 125-136, June, 1935.
19. ———: Contribution de la génétique à la solution de quelques problèmes physiologiques. *Soc. de Biol., Réun. plén.*, June, 1935.
20. ———: Blood group inheritance. *Nature,* **136,** 432, Sept., 1935.
21. Hall, Sir A. Daniel: The planning of agricultural production. *Nineteenth Century,* **118,** 426-433, Oct., 1934.
22. ———: The flight from the fields. *Ibid.*, **119,** 533-545, May, 1935.
23. ———: Tulip species of recent introduction. *J. Roy. Hort. Soc.*, **60,** 218, 1935.
24. ———: Species of Tulipa for the garden. *Ibid.*, **60,** 238-245, June, 1935.
25. La Cour, L.: Technic for studying chromosome structure. *Stain Technol.*, **10,** 57-60, April, 1935.
26. Lawrence, W. J. C., and Scott-Moncrieff, R.: The genetics and chemistry of flower colour in Dahlia: a new theory of specific pigmentation. *J. Genet.*, **30,** 155-226, March, 1935.
27. Mather, K.: Reductional and equational separation of the chromosomes in bivalents and multivalents. *Ibid.*, **30,** 53-78, Jan., 1935.
28. ———: Meiosis in *Lilium. Cytologia,* **6,** 354-380, May, 1935.
29. Moffett, A. A.: Cytological studies in cultivated pears. *Genetics,* **15,** 511-518, Nov., 1934.

30. ———: Chromosome number and pollen germination in pears. *J. Pomol.*, **12,** 321-326, 1934.
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32. Philp, J.: Aberrant albinism in polyploid oats. *J. Genet.*, **30,** 267-302, March, 1935.
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34. Richardson, M. M.: Meiosis in *Crepis,* I. Pachytene association and chromosome behaviour in *Crepis capillaris* (L.) Wallr. and *C. tectorum* L. *J. Genet.*, **31,** 101-117, June, 1935.
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36. Sansome, F. W., and La Cour, L.: The genetics of grasshoppers: *Chorthippus parallelus. Ibid.*, **30,** 415-422, May, 1935.
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39. *J. John Innes Gard. Assoc.*, No. 1, 1934.

ENTOMOLOGY AND PLANT PATHOLOGY

18. PLANT PATHOLOGICAL LABORATORY, MINISTRY OF AGRICULTURE AND FISHERIES

As stated in previous reports, the activities of the laboratory are primarily concerned with administrative and advisory questions relating to the pests and diseases of plants and with a marked increase in the public interest in such questions, the opportunities for research on the part of the laboratory staff have been even fewer than usual. The following brief references indicate the types of work which have received attention during the year under review.

Colorado Beetle.—Further progress was made in the campaign to eradicate the pest in Kent and Essex, with results that so far as can be judged at present have been successful. With the further spread of the beetle on the continent of Europe, a complete survey of all potato crops in coastal areas, notably in proximity to seaports was organised.

Vine Phylloxera.—An outbreak of this pest took place in Southern England and largely in the interests of the export trade in nursery stock, action was taken under the Destructive Insects and Pests Act which appears to have been effective.

Imported fruit.—Owing to fear expressed by the Fruit-Growing industry that the Australian Tortricid Moth (*Tortrix postvittana* Walk.) might be introduced with fruit from those regions, many samples of fruit showing damage was obtained by the Ministry's inspectors for examination at the laboratory. Various insects were identified, but not the pest in question. Fruit from other regions was examined in connexion with other dangerous overseas pests, such as the apple Fruit Fly in apples from America.

Plant exports.—The usual work in connexion with the issue of Health Certificates has been increased by the requirement of Jersey and Denmark for certificates relating to the freedom from the eelworm *Heterodera schachtii* from the soil in which plant exports or potatoes were grown.

Local Orders under the Destructive Insects and Pests Acts.—Local Authorities in response to public opinion are taking an increased advantage of these Acts to deal with cases of neglect in controlling common and widely distributed pests and diseases, and the entomological and phytopathological aspects of the various Orders issued in consequence have been dealt with by the laboratory, as also have questions relating to the Sales of Diseased Plants Order.

Research.—Further attention has been paid to a supposed " degeneration " of certain stocks of Golden Spur daffodils, and the methods of infection of hyacinth bulbs by Soft Rot is under investigation. In collaboration with the Forest Products Research Laboratory at Prince's Risborough, experiments have been begun with the object of devising suitable methods of treating boxes, used for growing seedlings and for bulbs, that will prevent rapid decay without adversely affecting plant growth. Some preliminary work on the effect of soil treatment with salts of boron and manganese on the incidence of Marsh Spot of pea seeds has been carried out.

19. POTATO VIRUS RESEARCH STATION, CAMBRIDGE UNIVERSITY

The virus-free stocks have been maintained with the addition of a few new varieties. A certain number of glasshouse plants of Arran Victory which hitherto had exhibited no evidence of virus disease, early in the season were found to be suffering from an infection of the " X " virus. Neither its source nor the method of its spread have as yet been definitely discovered.

The work on immunity against the potato virus " X " has been continued and the isolation of the different strains of the virus perfected. The conversion of one strain to another by transference through sugar-beet has been repeatedly demonstrated. Protection against the more virulent forms of the " X " virus in the potato itself by previous infection with the attenuated strain has been found to be absolute both in the glasshouse and in the field.

Attempts to induce mutation in both the " X " and " Y " viruses have been made with only partial success in the case of the " Y ".

A series of experiments have been made to kill various viruses in the potato tuber by heat, but so far without success.

The work in relation to antisera against various potato viruses has been continued.

Investigation of plants of a variety of Schizanthus displaying a kind of Witch's broom formation was made and the plants found to contain a virus which there is good reason to believe is a modified strain of the " Y " virus and which in tobacco protects against the latter.

In continuing the work on the " streak " diseases of the potato five apparently distinct viruses have been obtained which in different varieties may cause top-necrosis. These differ from one another in the diseases they cause on certain test varieties, in their physical properties and in the methods by which they are transmitted. Virus " A " which was previously thought not to be sap inoculable to potatoes can be inoculated if a small amount of carborundum powder is added to the inoculum. The results obtained on infecting potatoes with any of these viruses varies with different varieties, and the reactions of a range of commercial varieties to infection have been determined.

The serological work with potato virus " X " has shown that all strains of this virus and the nearly related virus " D " contain a common antigen which is not present in the saps of plants infected with other viruses. Antiserum provides a rapid method of testing for, and identifying, virus " X ", and has also been found to give a convenient method of comparing virus suspensions quantitatively. Attempts to correlate the infectivity of the virus with the antigen have been made, and it has been found that loss of infection from infected saps produced by filtration, or precipitation, and inactivation by heat, alcohol, ageing or certain chemicals are all accompanied by a corresponding loss of serological activity. Inactivation by formaldehyde leaves the serological activity unimpaired. In this connection it was found necessary to do a considerable amount of work in the preparation of purified virus suspensions.

Throughout the year the routine work in selection and testing of virus-free stocks, and the testing of specimens received has been continued.

In 1935 about 4,000 seedlings were raised and tested as young seedlings for their resistance to *Phytophthora infestans*. About half of these were of purely domestic stock, and as has been previously found, were 100 per cent. susceptible. Nearly 50 per cent. of the seedlings derived from resistant parents were resistant when young, and about 300 of these have been retained for growing on and further testing in 1936.

A further 300 seedlings saved from previous years were grown in the field, and some in the insect-proof glass-house. Their resistance to *Phytophthora infestans* was retested, and all those in their third year retained their resistance, in tuber and haulm.

Seedlings that appeared healthy and which had been exposed to virus infection in previous years were inoculated into tobaccos, etc., and many were found to be infected with " Y " virus and one with " X ".

Samples of the above as well as about 600 seedlings raised in 1935 were grown in the field amidst virus infected stocks, and their reactions were noted.

Selections of the best seedlings of previous years were grown in isolation at Barley, but suffered badly from drought.

Fifteen samples were sent to Ormskirk, out of which eight remained free from Wart Disease (four of which had been free when tested in 1933).

A large collection of South American species, varieties, and hybrids received from Russia was grown, and their resistance to *Phytophthora infestans* was tested. A few of the hybrids were found to be resistant, but no fresh resistant species was found.

Observations on the specific gravity of resistant and susceptible varieties (to Phytophthora) showed no significant difference.

By the courtesy of the Director of the Low Temperature Station the effect of low temperature on *S. accaule, S. demissum* and domestic control plants, was observed.

A large number of seedlings of South American species and domestic hybrids were inoculated and it was found that several of them would act as carriers of the " X ", " Y " or foliar necrosis virus.

Ultrafiltration of Plant Viruses.—This work has been carried out at the Molteno Institute by kind permission of Professor D. Keilin, F.R.S. Various modifications in the difficult technique of preparation of the Gradocol ultrafiltration membranes have been designed and a paper is now in the press describing the preparation of these membranes and their application in plant virus studies. The main purposes of these membranes will be (i) measurement of the particle size of viruses, (ii) separation of viruses in a disease complex, and (iii) an assistance in the classification of plant viruses.

The particle size of several representative plant viruses has already been measured by means of this technique (9). It has also been found possible to separate two strains of the same virus by the use of the membranes (16).

Tobacco necrosis.—This virus has been found to occur in a high proportion of normal tobacco plants; it is confined to the roots as a general rule and visible symptoms only develop in the plant under certain environmental conditions. The origin of this virus affords one of the most interesting problems now under investigation. It is present in plants grown in sterilized sand under insect-proof conditions so that there appear to be only two alternative explanations of its presence. Either the virus is present all the time in the stem of the plant in some undetectable form and is passed through the seed, also in an undetectable form or quantity or the virus is arising spontaneously within the plant (9, 15). It is hoped that it will be possible to decide before very long which of these alternatives is the true explanation.

Virus diseases of horticultural and ornamental plants.—Owing to the increasing economic importance of these virus diseases and because of the large number of inquiries received some attention has been paid to this aspect of the subject. Several new virus diseases have been described and investigated (10, 11, 12, 13), and some new diseases of ornamental plants due to the virus of tomato spotted wilt have also been described (14).

The problem of colour changes in the flowers of stocks and wallflowers has been investigated (13) and the colour changes have been found to be due to infection with a virus transmitted by the aphis, *Myzus persicae,* from infected broccoli and other brassicas (11). Measures which will materially reduce the risk of contamination to wallflowers and stocks have been recommended.

In addition a colour variegation in the flowers of violas has been found also to be due to infection with an undescribed virus.

Entomology.—Field and laboratory trials on a fairly extensive scale have been continued with a view to the identification of the insect vector of potato virus " X ". As in previous years, a small percentage of apparently successful transmissions of the virus have been obtained with a species of Thrips but there is not yet sufficient evidence to warrant the assumption that this insect is the actual vector.

It is of interest to note that in the field trials, the trap plants *Datura Stramonium* and tobacco became naturally infected with at least 3 new viruses in addition to virus " X," one of which was a virus usually found affecting tomatoes in glasshouses and described for the first time this year (12).

Titles of papers issued during the year.

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4. ————: Russian research on the potato. *Camb. U. Agric. Soc. Mag.,* 1935.
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6. ————: Report of the Potato Synonym Committee on the potatoes sent for immunity trials to the Potato Testing Station, Ormskirk. *J. Nat. Inst. Agric. Bot.,* **3,** 386, 1933.
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11. ————: A virus disease of cultivated crucifers. *Ibid.,* **22,** 239-242, May, 1935.

12. ————: A new virus disease of tomatoes. *Nature,* **135,** 908, June, 1935.

13. ————: Colour changes in wallflowers and stocks. *Gard. Chron.,* **98,** 2537, Aug., 1935.

14. ————: Some diseases of ornamental plants caused by the virus of tomato spotted wilt. *J. Roy. Hort. Soc.,* **60,** 7, July, 1935.

15. ————: The problem of a plant virus infection. *Nature,* **136,** 395, Sept., 1935.

16. ————: Two strains of "streak": a virus affecting the tomato plant. *Parasitology,* **27,** 3, 450, July, 1935.

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20. PLANT PATHOLOGICAL LABORATORY, DEPARTMENT OF AGRICULTURE FOR SCOTLAND

Tomato diseases.—Research on the new phytophthora causing Toe-Rot in tomatoes was instituted, and some useful preliminary work on the fungus concerned, the distribution of the disease and methods of control, was carried out. This disease is in need of further investigation. A new virus disease causing giantism and much distortion was noted and is now being investigated at Cheshunt.

Leek diseases.—Research is in progress on White Tip, Mouldy Nose and Rust. Susceptibility to white tip is correlated with the slowing down of metabolic processes. Breeding experiments to produce immunity are in hand.

Potato diseases.—Experiments on the control of Corky and Common Scab were carried out by Dr. Foister and Mr. Pratt. Various compounds of the mercuric group have been found to be the best for control of the disease.

Mycological determination of the wart disease tests was again carried out.

Strawberry disease.—Research is being continued and the breeding experiments of the last few years are beginning to show interesting results. Field Trials on a larger scale will, it is hoped, be possible next season with certain strains that show resistance.

Much assistance both in advice and in seeds and seedlings of new crosses has been received from the John Innes Horticultural Institute.

The trade in flowers, an important and increasing side of horticulture, provides interesting questions, e.g. a new *Phytophthora* on Canterbury Bell was investigated.

21. SEED TESTING AND PLANT DISEASES DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

Cereal Diseases.

Disinfection of seed oats.—Work has been mainly directed to the evolution of a biological technique for the valuation of disinfectants. It was decided that a disinfectant should not be regarded as satisfactory unless it produced satisfactory control of the disease in question under conditions likely to produce the maximum incidence of disease. For this purpose it is necessary to determine what conditions are most favourable for the development of the disease, and this has been done with leaf stripe, *Helminthosporium avenae.* First tests of disinfectants under controlled conditions have been carried out.

A preliminary investigation has been made of the " short wet " method of seed disinfection. In using this method the disinfectant is applied to the seed in the form of solution but the quantity used is insufficient to make it necessary for the seed to be dried after disinfection and before sowing.

Further large scale field experiments have been carried out in collaboration with the County Instructors in Agriculture.

Potato diseases.

Ordinary or late blight (*Phytophthora infestans* (Mont.) de Bary).—The series of spraying trials again carried out with the object of determining the relative values of various fungicides in securing the control of this disease gave indecisive results owing to the slight incidence of blight attack during the season. The hot dry weather which prevailed during the summer months did not allow Burgundy mixture to show up to its best advantage and a very slight checking of the growth of the crop resulted from its application. The proprietary material which gave promising results in 1934 when compared with Burgundy mixture again held its own but owing to the slight intensity of the attack of blight its relative value against this disease cannot be estimated for 1935.

Preliminary work has been carried out with a view to determining the value of tuber disinfection at digging time for the prevention of blight attack on the tubers and storage diseases in general.

The study of varietal susceptibility to blight of haulms and tubers of various potato varieties has again been continued.

Common Scab (*Actinomyces scabies* (Thaxt.) Güss.).—Further work dealing with the control of this disease by disinfection of severely scabbed seed tubers before planting has been carried out in the Division and at various centres in the Province. The results from some fourteen field experiments indicate that under certain conditions almost complete control of the disease may be obtained by this method. The best results have been obtained where the rotation between successive potato crops is long (some six or seven years). This would indicate that the organism tends to die out in infected soils under Northern Ireland conditions if potatoes are not grown too frequently in the same land. In such cases the danger of the reintroduction of the disease by the use of scabbed tubers for seed purposes is real and may be largely avoided by the disinfection of such " seed " before planting. Significant results were not obtained when disinfected scabbed seed tubers were planted in land frequently cropped with potatoes.

The results from these experiments have indicated that the most satisfactory technique for use in the field consists of the instantaneous dipping of the tuber in a solution of an organic compound of mercury.

Fruit tree diseases.

Apple scab (*Venturia inaequalis* Aderh.).—Comparative tests with fungicides carried out with the object of determining whether the home made Bordeaux mixture recommended for the control of this disease can be improved upon have up to the present given negative results.

The apple tree manurial experiments laid down with the object of investigating the effect of manuring upon disease resistance were continued during the year, in co-operation with the Imperial College of Science, London.

Storage rots of apple fruits.—A thorough investigation of apple storage rots occurring in Northern Ireland has been made during the past two seasons and a report on the work which has been carried out up-to-date is being prepared for publication. This will represent the first serious attempt made to deal with apple storage rots in Ireland. Among the parasitic fungi isolated was *Corticium centrifugum* (Lev.), Bres, which causes " fish eye " rot of the apple fruit (1). This appears to be the first record of this disease occurring on home grown fruit in the British Isles.

Gooseberry rust (*Puccinia Pringsheimiana* Kleb.).—Further experiments carried out during the year have again shown that this disease may be successfully controlled by spraying the bushes with a weak copper fungicide in early spring.

Vegetable diseases.

Finger and toe of Brassicae (*Plasmodiophora Brassicae* Woron.).—Field experiments have been carried out in order to determine whether the mercuric chloride method of control recommended for use on a market garden scale could be improved upon. So far no material which has given better results than mercuric chloride has been found.

Preliminary experiments were made with the object of evolving a small scale technique for the evaluation of soil disinfectants in securing the control of this disease. The results obtained so far are encouraging but further confirmation is necessary.

Seedling blight of swedes (*Pythium de Baryanum* Hesse.).—It has been found that *Pythium de Baryanum* can attack seedling swedes before emergence above the soil, as well as producing " damping-off " after emergence. The pre-emergent phase can easily be overlooked, and non-appearance of the plants put down to other causes. This phase is encouraged by low temperature conditions, while post-emergent damping-off is favoured by high temperature. A possible method of control is germinating the seed under high temperature, and transferring to cooler surroundings after emergence. Seed disinfection with an organic mercurial seemed to have no controlling effect.

Diseases of ornamental plants.

Rose rust (*Phragmidium mucronatum* Pers. Schlecht.).—The oil-Bordeaux spray mentioned in last year's report in connection with the control of this disease was tested further in two nurseries. In one case spraying three times at fortnightly intervals commencing from early July resulted in very little rust being found at the end of September while no damage could be found attributable to spraying. In the second case, using four heavily infected varieties, the sprayings were given at eight day intervals commencing from early September. On examination of the plots at the beginning of October, all the sprayed bushes had developed clean young growth whereas the controls had produced very little young growth the most of which was heavily infected with rust.

Observations were made on a plot of bushes containing 16 varieties, most of which had been budded on the following stocks:—*R. canina, R. rugosa* and Kokulinsky's *canina.* While no marked differences were observed with regard to rust resistance, it was noted that the superior growth of the bushes on *R. rugosa* stock which had been noticed for the past two years, was still maintained. Two varieties extremely susceptible to rust had been budded on the following stocks:—*R. canina, R. rugosa, R. Manetti, R. multiflora japonica, R. laxa* and Kokulinsky's *canina* in July 1933. The plants budded on

R. Manetti and Kokulinsky's *canina* appear to be more rust resistant than the remainder.

Diseases of glasshouse crops.

Carnation wilt and stem rot (*Verticillium cinerescens* Wr. and *Fusarium* spp.).—The steam sterilisation of the top soil and the subsoil to a depth of two feet six inches was carried out in a portion of a carnation house in February 1934. The house was planted with cuttings taken from apparently healthy plants grown in houses where the disease had been prevalent. In the course of observations made over a period of nearly two years it was found that the incidence of disease was of equal intensity both in the case of plants raised in sterilised soil and grown in the sterilised portion of the house and those raised and grown in virgin soil, overlying the unsterilised subsoil.

Plants from a similar source on another nursery grown in virgin soil over cinders in a house with a concrete floor have shown less than 0·5 per cent. deaths in the same period.

Virus diseases of the tomato.—Spotted wilt was recorded on tomato and dahlia in 1933. Further cases have been noted and the disease has also been found on arum lilies and recently on geraniums grown in a nursery where spotted wilt was serious on tomato.

A virus disease of tomato was found in May 1935 in a local nursery where the tomato plants were dwarfed and bore yellow spots on the leaves. Specimens were submitted to the Research Station at Cheshunt where it was identified as one of the new virus diseases of the tomato recently recorded in England.

Mycology.

New records for addition to the fungus flora of Ulster have been made during the year.

ECONOMIC ENTOMOLOGY.

Fruit pests.

Apple Capsid (*Plesiocoris rugicollis*).—Repetition of the previous year's experiments at new centres confirmed the findings that petroleum oil emulsions and combinations of these with tar distillates are very satisfactory ovicides against the eggs of capsid bugs on apple. By the use of a combined spray adequate control of aphis and apple sucker was also secured.

Pear leaf blister mite (*Eriophyes pyri*).—An experiment was designed to compare the efficacy of lime sulphur (1 : 20) and an emulsified petroleum oil (7½ per cent.), both applied in February, in controlling this pest. The results showed that petroleum oil, in giving approximately 95 per cent. control, was decidedly superior to lime sulphur.

Blackcurrant gall mite (*Eriophyes ribis*).—An emulsified highly refined petroleum oil has again promoted satisfactory control in plots of blackcurrants where it was applied both before and after the flowering period. A significant feature of this treatment has been the freedom from the serious " scorching " and fruit-fall which are evident when sulphur sprays are used.

Strawberry aphis (*Capitophorus potentillae*).—Preliminary field and pot experiments to test the efficacy of the " warm-water " treatment in controlling aphis on strawberries gave promising results. Strawberry runners were sterilised in warm water at a constant temperature of 110° F. for twenty minutes, and after this treatment they were plunged into cold water. Root development was evidently checked by the treatment, but, except where there was a delay in the planting out of the runners, or where the runners were allowed to dry out, only a few of the plants failed to survive. The treated plants remained free from aphis and, although for a period after planting they were not so robust as untreated plants, they eventually became comparatively healthier in appearance.

Pests of root crops.

Turnip flea beetles (*Phyllotreta* spp.).—In a field experiment, plots of swedes were treated, during the seedling stages, with various insecticidal dusts, including nicotine, derris and naphthalene. The general infestation by this insect, however, did not reach the intensity experienced in the previous year, and in the experimental plots the beetles failed to appear in sufficient numbers to render possible the recording of significant results.

Carrot fly (*Psila rosae*).—Consistently satisfactory control of carrot fly on carrots has been obtained over a period of three years by the application of eight weekly dressings of crude naphthalene during the young stages of growth. This year experiments at two different centres were designed to examine the possibility of reducing the cost of control measures by using a substance with more enduring repellent powers. A proprietary mixture of orthodichlorbenzene and paradichlorbenzene showed the greatest promise in this respect, but, although the deterrent properties of this mixture were more lasting and fewer applications required, such advantages were counterbalanced by the higher cost of the material as compared with naphthalene.

Mushroom pests.—Experiments are in progress to elucidate the most satisfactory means of controlling certain insect and allied pests of mushrooms. Sciarid flies and their larvae have been successfully combated by dusting with pyrethrum powder and watering nicotine solution on the surface of the beds; woodlice have succumbed to applications of pyrethrum powder and to baits poisoned with Paris green; but various mites affecting mushrooms have, so far, resisted the measures directed against them.

Title of paper issued during the year.

1. Colhoun, J., and Muskett, A. E.: " Fish eye " rot of apples. *Gard. Chron.*, **97**, 418-419, 1935.

AGRICULTURAL PARASITOLOGY

22. INSTITUTE OF AGRICULTURAL PARASITOLOGY, LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE

Parasites of farm stock.—Work has been continued on a series of experiments, dealing with stock and their parasites, set up during the previous year. The results from the past season's observations with goats under the New System of Grassland Management, which is essentially a rotational grazing scheme, corroborate those of the two previous years (1). They show that animals which died from natural causes—with experimental more than with control animals—were found to be very heavily infested with various species of worms. The dominant species were the small Trichostrongyles of the fourth stomach and small intestine such as *Ostertagia circumcincta, O. trifurcata, Trichostrongylus axei, T. colubriformis* and *T. vitrinus*. These forms were picked up in great numbers during the late summer and early autumn. The highest mortality was recorded during November.

In the " Age Immunity " experiment in which goats, aged three years, with a light infection when put to graze on land known to be heavily contaminated by sheep and goats previously pastured on it, the results showed that there appeared to be no immunity present to parasitic infection.

Parasites of poultry and game.—Observations on the development of *Heterakis gallinae* in chickens were continued. These experiments seem to show that the age of the bird and the breed have a direct effect on the development of the worm. The presence of a high percentage of minerals in the diet would seem to have an inhibitory effect on the infestation (12, 13, 14).

Separate strains of *Trichostrongylus tenuis* from the partridge and the grouse have proved infective to chickens in which host, however, the disease has not yet proved fatal. The presence of magnesium in the diet has brought about a radical reduction of egg output but has not so far affected the duration of the infestation. It is not clear yet if this diminution of number of eggs of the parasite is due to an inhibition of laying powers or to a decrease in the actual number of worms which reach maturity. This is being investigated. Other elements are also being considered in this respect.

During the winter months the material obtained from nearly 400 partridges was identified and many interesting records noted (15).

Parasites of economic plants.—This work is principally concerned with nematodes of the genera *Anguillulina* and *Aphelenchoides.* Of the former, the species of greatest agricultural importance is the stem eelworm, *Anguillulina dipsaci,* which has been known for many years as a pest of potatoes, oats and clover. On all three crops, investigations have been conducted for some years past and are still being carried out on field plots and smaller scale experiments.

A plot for potatoes was set up in 1928 and has been planted with this crop every year since. A considerable range of potato varieties in commercial cultivation has been tested and all have been found susceptible to attack, whether early, second-early, or main-crop varieties. The main conclusion is that the incidence of attack decreases rather than increases even though potatoes are grown year after year on our clay land. The investigations are being continued with a view to testing such problems as the residual infestation in soil and the relation of the parasite to rotational crops (7).

Other strains of the parasite on such hosts as onions, carrots and plantains have been maintained for experimental purposes. Investigations are being conducted on the pathology of gall-formation in the case of *Anguillulina tritici* and *A. agrostis.* Of the eelworm infested material which has recently been sent to the Institute from various parts of the British Empire a serious disease of yams in Nigeria, due to a species of *Anguillulina,* has been investigated (11).

Other work has included research on a saprophagous nematode (5) and on a new species producing galls on grass (3).

A plot devoted to the strawberry eelworm, *Aphelenchoides fragariae,* has been maintained for some years and is now well stocked with plants showing " cauliflower " and " red plant " symptoms which it is hoped to use in investigations on the connection between *A. fragariae* and the causation of these disease symptoms. A new species of *Aphelenchoides* affecting British narcissus bulbs and leaves has been described (10).

Investigations have been continued on plant diseases due to *Heterodera* spp. A study has also been made of cyst-like bodies of common occurrence in British soils which have been confused with the cysts of *Heterodera schachtii* (6). Strains of *H. schachtii* parasitic on peas, oats and sugar beet have been studied with special reference to their methods of dissemination and spread. An important discovery is that of the cysts of *H. schachtii* in bags of imported sugar beet seed (8).

Methods of sterilising potato " seed " tubers and sugar beet seed to prevent the introduction of this nematode to uninfected land have been under investigation.

Field and laboratory experiments on the use of chemical substances and fertiliser dressings as a means of controlling *H. schachtii* are being carried out.

Parasites of insect pests.—Encysted nematodes infesting caterpillars, forwarded to the Institute from the Marquesas Islands, were identified as *Rhabditis coarctata* (4).

Data obtained from the dissection of *Phyllotreta* beetles collected during 1932 and 1933 have been analysed and figures showing the percentage infestation obtained. There is a definite variation in the incidence of infection for the years 1931, 1932 and 1933, which may be associated with the weather conditions (9).

Titles of papers issued during the year.

1. Morgan, D. O., and Oldham, J. N.: Further observations on the effect of heavy stocking on the worm burden under a system of rotational grazing. *J. Helminth.*, **12**, 177-182, 1934.
2. Solomon, S. G.: Some points in the early development of *Cysticercus pisiformis* (Bloch 1780). *Ibid.*, 12, 197-204, 1934.
3. Goodey, T.: *Anguillulina cecidoplastes* n.sp., a nematode causing galls on the grass, *Adropogon pertusus* Willd. *Ibid.*, **12**, 225-236, 1934.
4. Oldham, J. N.: On the occurrence of *Rhabditis coarctata* (Nematoda) on caterpillars in the Marquesas Islands. *Ibid.*, **13**, 13-18, 1935.
5. Goodey, T.: On *Cylindrogaster curzii* n.sp., a saprophagous nematode. *Ibid.*, **13**, 19-24, 1935.
6. Triffitt, M. J.: On cyst-like bodies, resembling cysts of *Heterodera schachtii* of common occurrence in British soils. *Ibid.*, **13**, 59-66, 1935.
7. Goodey, T.: Observations on a field plot experiment with *Anguillulina dipsaci* on potatoes. *Ibid.*, **13**, 91-102, 1935.
8. Triffitt, M. J.: On the origin of strains of *Heterodera schachtii* occurring in Britain, with special reference to the beet-strain. *Ibid.*, **13**, 149-158, 1935.
9. Oldham, J. N.: Further observations on the incidence of parasitism of flea beetles by the nematode, *Howardula phyllotretae*. *Ibid.*, **13**, 163-166, 1935.
10. Goodey, T.: *Aphelenchoides hodsoni* n.sp., a nematode affecting narcissus bulbs and leaves. *Ibid.*, **13**, 167-172, 1935.
11. ———: Observations on a nematode disease of yams. *Ibid.*, **13**, 173-190, 1935.
12. Clapham, P. A.: On the experimental transmission of *Syngamus trachea* from starlings to chickens. *Ibid.*, **13**, 1-2, 1935.
13. ———: The treatment of gapeworm disease. *Ibid.*, **13**, 3-8, 1935.
14. ———: On nodules occasioned by gapeworm in pheasants. *Ibid.*, **13**, 9-12, 1935.
15. ———: Some helminth parasites from partridges and other English birds. *Ibid.*, **13**, 139-148, 1935.

23. DIVISION OF HELMINTHOLOGY, DEPARTMENT OF ZOOLOGY, UNIVERSITY OF EDINBURGH

Parasites of poultry.—The main researches during the year have been concerned with the parasites of poultry and have been carried along two main lines:—

(i) The survey of intestinal helminths in Scottish poultry has been continued and observations on 715 birds have been added to those made during the previous year. As previously reported, *Heterakis gallinae* and Capillaria spp. continued to be the worms most frequently found; *Ascaridia galli* and *Davainea proglottina* were much less common. A full analysis of the two years' survey will be made and special attention will be directed to the possible correlation between the presence of worms and poultry diseases.

(ii) The experiment, mentioned in the previous report, to test the value of various chemicals on poultry runs infested with the eggs of worms was carried out during the spring and summer of this year. In the first place it was decided to use the chemicals generally recommended for cleaning up infested ground. These included salt, lime, sulphate of ammonia and sulphuric acid and applications in excess of the amounts recommended were applied. Clean birds placed on the treated runs were found to become quickly infected with various species of helminths and the experiment clearly indicated that these chemicals are of little value, at any rate against the eggs of nematodes.

Parasites of sheep.—A study has been made of the worm-burden of a group of lambs reared on a field treated with kainit and sodium chlorate and a comparison made with that in a similar group of lambs on untreated ground. An examination of the intestinal contents of 20 lambs from this experiment is now in progress.

The intestinal contents of two lambs from an experiment on the value of copper sulphate against intestinal worms are also being fully examined for worms.

Other work.—Animals which died at the Scottish Zoological Park during the year have been examined for worms and many useful specimens have thereby been added to the helminth collection of the Department of Zoology.

A detailed analysis of the helminths in the alimentary canal of a sheep suffering from " scrapie " was carried out at the request of the Director of the Moredun Institute.

ANIMAL PATHOLOGY

24. RESEARCH INSTITUTE IN ANIMAL PATHOLOGY, ROYAL VETERINARY COLLEGE

MASTITIS IN CATTLE.

Diagnosis.—It has been found that streptococci occasionally occur in milk, which on blood agar prove strongly haemolytic, but which nevertheless do not produce mastitis and are entirely non-pathogenic to laboratory animals. These organisms are not of very frequent occurrence, nor are they numerous when they do occur; but they are found often enough to cause possible confusion in the diagnosis of mastitis (1).

The sorbitol-trehalose test for streptococci.—It has been suggested that certain strongly haemolytic streptococci of human origin can be distinguished from similar organisms from animals by means of their reactions with sorbitol and trehalose: those from human sources fermenting trehalose only and those from animal sources fermenting sorbitol only. This test would be of considerable value in determining the ultimate origin of streptococci of this type found in milk, which may cause milk-borne epidemics, and a large number of strains were accordingly tested to ascertain the validity of the method. Results showed that the test is of considerable value: of 21 strains from milk, only three fermented trehalose, and other evidence supported the contention that these were probably of human origin (2).

Bacteriological standards for mastitis milk.—Mastitis streptococci are harmless to man, but they cause deterioration in milk. As most bulk milk contains these organisms, experiments have been carried out to determine whether it would be possible to set a standard to limit the permissible contamination from this source. The experiments have shown that it would be impossible to fix a standard based on the number of mastitis streptococci present, as this number undergoes large and unpredictable variations from week to week—variations which seem to be due to a real fluctuation of the numbers present in the udder rather than to technical defects in sampling or culturing (3).

Control.—Attempts at the control of contagious streptococcal mastitis have been made since 1929 on seven herds. The method adopted has been the comparatively simple one of testing the milk of all cows every few months, and always milking cows found to be infected after the uninfected cows. In some of the herds it has been possible to keep infected cows separate from uninfected. Results varied from herd to herd, but in general a marked improvement followed when the control method was consistently applied, and this was greater when it was possible to segregate the infected animals. Only two herds were completely freed from the disease, and in one of these disposal of a number of infected animals was an important factor in securing freedom.

BACTERIOLOGICAL EXAMINATION OF MILK PRODUCTS.

Samples of cream, butter, and cheese, made from pasteurised or unpasteurised milk, were examined for tubercle bacilli and *Br. abortus*. It appeared that pasteurisation of the milk or cream used ensures freedom from these organisms (4). In cheese, if either organism is present immediately after manufacture, it is found to disappear during the ripening period by a process of autosterilisation.

JOHNE'S DISEASE.

A study has been made of the behaviour of cattle infected with Johne's disease when subjected at intervals to intradermal tests with johnin. An account of this work together with post-mortem examinations for tuberculosis and Johne's disease of a number of the reacting animals (5) has now been published. The results have provided information as to the usefulness of the johnin test for diagnosis. Out of 53 animals which gave a clear reaction to the test, 39 were proved on post-mortem examination to be infected with Johne's disease, in seven definite proof was not provided and in the remaining seven post-mortem examination was not possible although the clinical history in these cases was suggestive of Johne's disease. Altogether in 11 of these 14 animals there was presumptive evidence of Johne's disease. Six animals found to be affected with Johne's disease on post-mortem examination had not reacted to johnin but three of them were tested once only and four of the six were at an advanced clinical stage so that their failure to react was not surprising.

Repeat tests with johnin on a number of animals showed much variation in the extent of reaction, a result which was attributed to variations in the reacting power of the animals.

GLANDERS AGGLUTININS.

The opportunity was taken to test the blood serum of 314 British horses for glanders agglutinins. It was found that specific agglutinins for the glanders bacillus were present in large amount in 90 per cent. of the samples. Since glanders has been absent from this country since 1926, the agglutinins found could not possibly have developed in response to infection with the glanders bacillus. Similar agglutinins were also present in the sera of a few cattle, swine and goats—animals which do not naturally suffer from glanders. The work can be viewed as a contribution to the study of so-called normal agglutinins in the blood of various species of mammals (6).

A practical application of the work arises from the finding that injections of mallein as now carried out have no influence on the amount of agglutinins in the blood.

CONTAGIOUS ABORTION.

Experimental eradication scheme.—Observations have been continued in seven herds selected as suitable for the scheme, from six to nine tests having been made at intervals of approximately three months. The herds were selected as representing different conditions of size, method of maintenance and facilities for segregating infected animals. The total number of cattle on an average at each test was 485. In all cases the proportion of infected animals, originally high (23-49 per cent. including the heifers), has declined. Three are now free from infection, and two more virtually free; while in the two others the incidence is only 5-10 per cent.

Titles of papers issued during the year.

1. Minett, F. C., and Stableforth, A. W.: Non-pathogenic haemolytic streptococci occurring in milk. *J. Dairy Res.*, **5,** 223-232, Sept., 1934.
2. Minett, F. C.: Differentiation of *Str. pyogenes* from man and animals by the sorbitol-trehalose test. *J. Path. Bact.*, **40,** 357-364, March, 1935.
3. Pullinger, E. J.: Mastitis streptococci in bulk milk. *J. Dairy Res.*, **6,** 369-382, Sept., 1935.
4. ————: Examination of milk products for tubercle bacilli and *Brucella abortus*. *Lancet*, **228,** 1342-1344, 8th June, 1935.
5. Minett, F. C.: The diagnosis of Johne's disease by the use of johnin. *J. Comp. Path. and Therap.*, **48,** 125-137, June, 1935.
6. Lovell, R.: Studies on normal agglutinins. The agglutination of *Pf. mallei* by normal horse sera. *J. Roy. Army Vet. Corps*, **6,** 69-82, January, 1935.
7. Stableforth, A. W.: Mastitis in dairy cows and its control. *J. Min. Agric.*, **41,** 945-955, January, 1935.
8. ————: The rearing of calves free from the major diseases of cattle. *Vet. Rec.*, **15,** 189-192, Feb., 1935.
9. Minett, F. C.: Haemoglobinuria. *Proc. Roy. Soc. Med.*, **28** (Section of Comparative Medicine), 22-28, April, 1935.

25. INSTITUTE OF ANIMAL PATHOLOGY, CAMBRIDGE UNIVERSITY

FILTERABLE VIRUSES.

Contagious pustular dermatitis.—Field experiments, undertaken to determine whether sheep and lambs can be rendered resistant to outbreaks of dermatitis were continued. Satisfactory results have been obtained in lambs of from six to twelve months of age but in very young animals the reactions were of such severity as to preclude the use of the vaccine under field conditions. There was no evidence that, under experimental conditions lambs born of vaccinated ewes possessed an appreciable amount of resistance to an artificial infection. It was found in the case of infected flocks, however, that the progeny of ewes vaccinated during pregnancy did possess a slight degree of immunity.

Attempts to induce immunity by means of virus rendered inert by heat, formalin or irradiation, or by mixtures of virus and immune serum were not successful.

BACTERIOLOGY.

The investigation into the flora of the intestines of sheep was continued. A technique for the isolation of non-pathogenic anaerobes was evolved and the organisms obtained were typed. Special attention was paid to the presence and isolation of *Cl. septique* and *Cl. tetani,* as well as the types of *Cl. welchii* present in the intestines.

The toxicity of the intestinal contents of normal sheep was also investigated.

It having been observed that filtrates from the contents of the intestines of normal sheep seemed to possess the power of increasing the activity of the toxin of *Cl. welchii,* type D, the matter was investigated further. It has been found that a substance present in the normal intestine is capable of producing a pronounced increase in the activity of this toxin but is without effect upon the toxins of types A, B and C. This observation is of practical value in the diagnosis of enterotoxaemia of sheep and lambs.

Survival of Br. abortus outside the body.—Observations on the power of survival of *Br. abortus* in infected material have been continued. From the aborted foetus exposed as nearly as possible to natural climatic conditions the maximum period over which the organism was recovered was 182 days. In other cases it survived 73 and 134 days respectively. From foetal membranes it was isolated up to 118 days in one case and 147 days in another.

Suspensions of freshly isolated cultures added to river water did not remain viable for more than 53 days; the duration of infectivity of contaminated discharges has not yet been determined.

Excretion of Br. abortus from the body.—In order to ascertain the extent to which *Br. abortus* may be excreted in the faeces and urine preliminary tests have been carried out with samples of material taken bi-weekly from two non-pregnant lactating cows which throughout the period (three months in one case and four months in the other) were excreting the organism in their milk. During this time only two samples of faeces from one animal and one sample of urine from each were found to be infective. The actual importance of these channels of excretion can only be assessed, however, when a larger number of animals has been examined.

PATHOLOGY.

"Swayback" in lambs.—The general pathology of this disease has been studied in detail. Although not completed the general conclusion is that the disease should be regarded as belonging to the demyelination group of nervous diseases. The situation and nature of the lesion bear some relationship to those of Schilder's disease in man (*encephalitis periaxialis-diffusa*).

Lesions produced by B.C.G.—The nature of the lesions produced by B.C.G. vaccine has been studied by the intravenous injection of this organism into rabbits. The development, and type of reaction, and the fate of the organisms have been examined over periods ranging from 24 hours to 205 days and a comparison has been made of the tubercles produced by B.C.G., and the bovine, human and avian types of virulent tubercle bacilli.

Fowl paralysis.—Serological tests have been carried out to ascertain the feasibility of diagnosing the disease during the latent stages. The results have not been encouraging. Experiments undertaken to determine the possibility of transmission of the disease by inoculation have been concluded. A smaller proportion of positive results was obtained than in the former series of experiments, and it was found to be impossible to transmit the causal factor to other chicks of a suitable age. Experiments have suggested that transference of the disease through the egg may play an important part in the spread of the disease.

BIOCHEMISTRY.

Phosphorus deficiency.—Sheep, fed on a diet containing only enough phosphorus to allow of a daily intake of from 1·0 to 1·5 g. per animal but adequate in other minerals, protein and starch equivalent, digested their ration to a normal extent but did not gain in weight as did control animals on a similar basal ration but with phosphate added, thus proving that phosphorus deficiency was a limiting factor in body growth and utilisation of food. After five months on the low phosphate diet, the animals showed a decrease in the inorganic phosphorus content of the blood, which fell from over 4·5 mg. to 2·0 mg. per 100cc. and a reciprocal rise in the calcium content of the blood.

Chemical examination of the bones revealed that after 18 months on experiment the total ash content of the vertebrae, ribs, scapulae and skull had fallen over 25 per cent. and of the long bones over 8 per cent.

The pasture on many of the hill farms of Northumberland and Yorkshire has been shown to contain less than 0·4 per cent. P_2O_5 during a considerable portion of the year, with a minimum of 0·25 per cent. P_2O_5 in some cases, so that a shortage of grass during the summer months, when its phosphate content is at its maximum, might result in a phosphorus deficiency with results similar to those depicted above.

Lactation tetany.—During the spring of 1935 it was found that in certain districts in which lactation tetany occurs there was a fall in the blood magnesium of the cattle during the first few weeks at grass. It has been shown that this fall takes place if cattle are moved in the early spring from farms in districts where it does not normally occur to premises where the disease is met with. During the spring of 1935 an investigation was carried out on a farm in Lincolnshire where lactation tetany has been prevalent in the past few years, to ascertain whether feeding mineral mixtures containing magnesium would prevent the decrease of this salt in the blood of the cattle. It was found that while the average level of the blood magnesium in the treated animals was 2·77mg. per 100cc., that of the untreated control animals was 1·81mg. A survey is being made of the chemical composition of the pastures in affected and non-affected areas.

PHYSIOLOGY.

Cl. welchii.—The study of the physiological actions of the toxins of *Cl. welchii* has been continued and their general action has been determined. It has been shown that their first effect, following intravenous injection into normal animals, is the stimulation of smooth muscle. This effect is clearly seen in the reaction of the smooth muscle of the peripheral blood vessels and bronchi. Later the heart muscle is affected, followed by depression of the higher centres and death.

Earlier work had shown that non-lethal doses of the toxins produced tissue desensitisation and this effect has been studied further. Toxin of the " B " type was used for this purpose. The desensitisation was found to be unassociated with any immunological reaction, for it was non-specific and could be produced in isolated organs. It was also observed that a desensitised animal reacted to a larger dose of toxin in the same manner as an animal which had received a lethal dose of heated toxin.

Experiments were carried out to determine whether a rapid method for the identification of the several toxins of *Cl. welchii* could be evolved. The most promising results were obtained with isolated rabbit heart preparations. By this means it was found possible to classify the toxins at a glance as " A " or

" D ", and " B " or " C " and if the amount of toxin passing into the heart was known the individual toxins could be recognised. It was found impossible to recognise the composition of a mixture of toxins by this method.

It would seem that the differences in the actions of the several toxins of *Cl. welchii* are differences of degree rather than of kind.

IMMUNOLOGY.

Vaccines in oily excipients.—A preliminary experiment has been completed on the protection afforded to calves against infection with tuberculosis by the subcutaneous injection of B.C.G. or virulent bovine tubercle killed by formalin in oily excipients. The respective antigens were suspended in a mixture of gum acacia and olive oil or liquid paraffin. The results with B.C.G. have been very encouraging since three animals out of four were apparently completely immune while the fourth showed only very slight lesions six months after the administration of a test dose of virulent tubercle bacilli by the mouth. The protective value of the dead emulsion was less conclusive. The olive oil suspensions induced smaller local reactions than the suspensions in liquid paraffin.

Diagnosis of infection with Br. abortus.—Numerous experiments have been carried out to test the efficacy of a variety of diagnostic agents prepared from *Br. abortus* in the diagnosis of contagious abortion of cattle. Promising results were obtained with preparations consisting of the neucleo-protein fraction of the organisms and of precipitates from liquid cultures, but sufficiently extensive field trials have not yet been carried out to prove their value.

Tuberculin and Johnin.—Investigations have also been continued into the preparation of tuberculins and johnins on synthetic media especially with regard to the keeping qualities of such products.

PARASITOLOGY.

Helminthology.—Work previously in progress on nematodes parasitic in sheep has been continued, with special reference to the behaviour and ecdysis of the free-living and infective larvae, the general object being to determine more precisely the conditions governing their survival and ability to infect new hosts.

Tame rabbits have been infected with a nematode obtained from wild rabbits and attempts have been made to find suitable laboratory animals as hosts of nematodes of other species. In this way it is hoped to overcome the difficulties which are inseparable from the proper study of parasitic worms in the natural host when this is one of the larger herbivora.

Protozoology.—A species of *Trichomonas* has been grown in cultures from material obtained from cattle and the alleged relationship of this organism to abortion in cattle is being studied. An examination of cattle on various farms in or near the Cambridge area is being made to determine the incidence of *Trichomonas* in both abortion-free herds and herds in which abortions have occurred. A suggestion that the species of *Trichomonas* found in the vagina and uterus of cattle may be the same as the so-called *Trichomonas* found in the rumen is also being investigated.

Further work has been done on Blackhead disease of turkeys and on *Sarcocystis*.

TOXICOLOGY.

Buttercups.—The work on buttercups has been concluded. An irritant oil—Protoanemonin—has been isolated and its variation in *Ranunculus bulbosus* has been studied throughout the growing season. The amount of Protoanemonin present in most of the common buttercups at the period of full flower has been determined.

Organic acids.—A study has been made of the physiological actions of various organic acids prepared from a number of plants considered poisonous. The chief of these were *R. sceleratus, Adonis vernalis, Tanacetum vulgare* and bracken. The general action of these acids was established by means of intravenous injections into mice and rabbits and by a study of their effect on isolated organs. All the acids examined possess very similar properties which vary little from the accepted action of acids belonging to this class of substances. It was established that although these substances were highly toxic when given intravenously, massive doses were necessary by the mouth before toxic effects were produced. This work has indicated that, as far as bracken is concerned, with the possible exception of tannic acid, the organic acids present in the plant play little or no part in its toxic action.

Experiments were also carried out with other substances obtained from bracken. Most of these were in an impure state and clear cut results were difficult to obtain. This work has now been discontinued.

The stock of poisonous plants has been kept true to name and the harvesting, threshing and sowing of all annual plants has been accomplished.

Titles of papers issued during the year.

1. Bosworth, T. J., and Glover, R. E.: A differential character of *Cl. welchii*, Type D. *Proc. Roy. Soc. Med.*, **28,** 1004, 1935.
2. Glover, R. E.: Production de la tuberculine en milieu synthétique. *Bull. Off. Inter. Epiz.*, **10,** 273, 1935.

3. Innes, J. R. M.: "Swayback." A congenital demyelinating disease of lambs with affinities to Schilder's encephalitis. *Proc. Roy. Soc. Med.*, Jan., 1936.
4. Lapage, G.: The second ecdysis of infective nematode larvae. *Parasitology*, **27**, 186-206, 1935.
5. ———: The bearing of the physiology of parasitic nematodes on their treatment and control. 1-21. *Imperial Bureau of Agricultural Parasitology*, London, 1935.
6. ———: The second ecdysis of the infective larvae of certain trichostrongylidae in solutions of sodium sulphide and of organic compounds containing sulphur. *J. Helminth.*, **13**, 103-114, 1935.
7. ———: The behaviour of sterilised exsheathed infective trichostrongylid larvae in sterile media resembling their environment in ovine hosts. *Ibid.*, **13**, 115-128, 1935.
8. ———: Blackhead disease of turkeys. *J. Min. Agric.*, **42**, 246-251, 1935.
9. ———: The costly nematode. *Discovery*, **16**, 266-267, September, 1935.

26. VETERINARY LABORATORY, MINISTRY OF AGRICULTURE AND FISHERIES

Foot-and-Mouth Disease Experimental Station, Pirbright.

(Under the general direction of the Foot-and-Mouth Disease Research Committee.)

The work of the station was mainly concentrated on the study of the different immunological types of virus, and the behaviour of certain anomalous strains in relation to immunity against the different type strains and to the various possible combinations of those strains. During the year under review, work was continued on the mechanism of the natural transmission of infection.

Veterinary Laboratory, Weybridge.

Babesiasis and Anaplasmosis.—The African, West Indian and South American strains were maintained.

Contagious abortion of cattle.—During the year 20,775 doses of the living vaccine were prepared and issued, and 1,166 agglutination tests were performed in connexion with questions of vaccination.

The investigation of the distribution of *Brucella abortus* in the body of the "carrier" cow, reference to which was made in the last report, was completed (1).

A summary of the work is as follows:—

(i) The tissues of 32 naturally infected cows were examined for the presence of *Br. abortus*.

(ii) The organism was isolated from 13 different sites in 26 cows; eight of the sites consisted of lymphoid tissue.

(iii) *Br. abortus* was isolated from the iliac glands in 52 per cent. and from the pharyngeal lymphatic glands in 28 per cent. of the cows examined.

(iv) In view of the high percentage of infection in the iliac glands and their close relationship to the uterus, it appears reasonable to regard them as predilection sites of *Br. abortus* in carrier cows.

(v) The strains of brucella isolated were subjected to the usual identification tests and proved to be typical *Br. abortus* types.

(vi) The results obtained from the inoculation of guinea pigs with milk indicate that there is little correlation between the serological titre of the milk and the presence of the organism in it.

(vii) *Br. abortus* was isolated from 63 per cent. of guinea pigs inoculated with known infected material.

Work under the Agricultural Research Council's experimental eradication scheme was continued, and 5,907 bovine blood samples were tested for the presence of brucella agglutinins.

Three hundred and sixty-one samples were examined biologically for the presence of *Br. abortus*.

Further work was carried out on the use of killed cultures as vaccines for cattle, and also on *Brucella* infections of horses, in which a killed vaccine appeared to give favourable results.

Tuberculosis.—During the period under review a considerable amount of work was carried out to ascertain the relative value of different methods (double intradermal, sub-caudal fold and vulva) of tuberculin testing of cattle.

The inquiry was carried out partly at the Laboratory and partly in a large commercial dairy herd maintained under average farm conditions.

A total of 3,176 tuberculin tests were made, and in addition 55 animals that had given positive or doubtful reactions to the tests were autopsied, and biological examinations made of selected tissues. This work is being continued.

The use of B.C.G. vaccine in selected herds was continued, and during the year 693 doses of the vaccine were prepared and issued.

Parasitic gastritis of sheep.

(a) *Migration of infective larvae.*—It has been found that the structure of the shoots of herbage plants has an important influence on the migration of infective larvae on to the plants. On grasses there is a marked tendency for the larvae to turn off the stem on to the lowest leaf and to accumulate on the under side of this leaf. Similarly on herbage plants which produce their leaves in whorls, most of the larvae are found on the lowest whorl: in both these cases the lowest leaves are commonly coarse and unpalatable. In clovers there is no possibility of diversion of the larvae in this way, and they migrate on to the palatable trifoliate blade of the leaf. These observations are important, as sheep are known to be very selective in their grazing, and this selectivity will influence their intake of parasites.

(b) *The effect of moderate infestations on the health and growth of lambs.*—Four of a group of nine lambs, all kept together in an indoor pen, were given daily doses of 500 mixed Trichostrongylid larvae. It was found that the control lambs thrived much better than the infected ones over a period of several months: but, while one susceptible animal died of typical parastic gastritis, the other three remained healthy and without definite symptoms of the disease. Thus it appears that infestations of moderate intensity may interfere with the growth of lambs without producing disease; this possibly accounts for the bad thriving of many lambs in late summer and autumn.

(c) *The relation between housing lambs at night and parasitic gastritis.*—Ten lambs were removed from their grass plot every night and housed: it was found that they became more heavily infested than 10 controls which remained on their grass plot continuously, although the latter must have contaminated their plot more heavily, since it received all faeces. The probable explanation is that lambs left on grass all night have additional time to feed, since those housed received no food while shut up: if this is correct it emphasises further the importance of nutrition in relation to parasitic gastritis.

(d) *Treatment of parasitic gastritis caused by parasites other than Haemonchus contortus.*—Work was carried out on the effect of mixtures of copper sulphate with various samples of nicotine sulphate on *Trichostrongylus retortaeformis* in the rabbit (this worm is very closely allied to those which are responsible for parasitic gastritis in sheep). Results up to the present, however, have been inconclusive.

(e) *The diagnosis of parasitic gastritis.*—Further work was done on the enumeration of parasitic worms as an aid to diagnosis, and on a new method devised for enumerating the various species which may be present in an infected animal (11). This procedure is considered advantageous where it is desirable to obtain fuller information on the nature of an outbreak than is required for ordinary diagnosis, e.g., in scientific investigation of field outbreaks.

Acute parasitic bronchitis in adult cattle.—Investigations were made into several outbreaks of this condition (10) and the particular susceptibility of Channel Island cattle appears to have been established.

The condition may, at times, develop so rapidly that death takes place before any of the larval worms appear in the faeces, i.e., in less than six weeks after the acquisition of infection. From the number of outbreaks which were encountered this disease appears to be more prevalent in adult cattle than is indicated by the scanty references to be found in the literature. Losses may be severe.

Syngamiasis.

(a) *The longevity of infective larvae of the gapeworm in intermediate hosts* (5).—The period for which infective *Syngamus* larvae can be carried has been extended to four years, four and a half months for the earthworm, and for the common garden snail, *Helix aspersa,* to one year, one and a half months (5).

(b) *The anthelmintic effect of garlic oil on gapeworms.*—Trials with 82 infected chicks were carried out on the value of garlic oil and allyl sulphide (synthetic garlic oil) for the treatment of gapeworm infestation, which had elsewhere been found useful. On post-mortem examination at the end of the experiment, the average infestation was found to be higher in the treated chicks than in the controls, the average infestations being 12·7 and 11·7 pairs of worms respectively.

Obscure disorders of young pigs.—A survey of the disorders of young pigs, other than those associated with well-known specific infections, has been commenced in co-operation with the Agricultural Research Council's Committee on Swine Fever, Necrotic Enteritis and Allied Disorders of Pigs. This work is at present being done from Weybridge, but will probably be continued later from other centres. To date much of the recorded mortality has been associated with malnutrition, the commonest type of disorder being apparently the anaemia of sucklings controllable by iron therapy.

Metabolic disorders of farm animals.—The work of the previous year has been continued and considerable further data have been acquired on hypocalcaemic and hypomagnesaemic conditions throughout the various counties of England (13).

Blood studies on the clinically normal cow throughout the sexual cycle have been completed on material obtained from the National Institute for Dairy Research at Reading, and correlated with data of cows suffering from metabolic disorders —chiefly lactation tetany, milk fever and acetonaemia (14). Acetonaemia of the dairy cow, particularly in Jerseys, seems to be becoming more prevalent and experiments are in progress designed to throw light upon its etiology and on methods of treatment.

Observations on pregnancy toxaemia and lambing sickness of ewes have also been commenced—disorders in which preparturient acetonaemia, commonly associated with distinct hypoglycaemia and hypocalcaemia, is a feature. Fatty degeneration of the liver is the general rule and this feature is being investigated histologically. The observed disturbance of carbohydrate and fat metabolism has no obvious relation to diet and the etiology of the condition is still obscure.

Physiology of certain metals.—A study has been made of the fate of parenterally introduced calcium and magnesium salts in the animal body. Work on the fate of arsenic in the bodies of birds (turkeys) was concluded. In the course of this investigation methods of rapid estimation of arsenic in tissue were developed (16). Work has been commenced on the physiology of copper and of lead; the former in connection with chronic copper poisoning and the use of copper compounds for therapeutic purposes, and the latter in connection with the possible association of plumbism with " sway-back " in lambs.

Newcastle disease of fowls.—Immunological tests have been carried out to determine the relationship between strains of Newcastle virus obtained in England, Dutch East Indies, Philippine Islands, India, Korea and Japan.

A summary of this work(3) is as follows:—

(i) Newcastle disease has been identified in England, Dutch East Indies, Philippine Islands, India, Ceylon, Korea, Japan and Australia.

(ii) The English, Dutch, Philippine, Indian, Korean and Japanese strains of the virus have been proved to be immunologically indistinguishable.

(iii) Newcastle disease is a separate entity, bearing a superficial resemblance to fowl plague, but differing from it in the period of incubation, symptoms, lesions, infectivity, pathogenicity for pigeons, and immunological properties.

(iv) The wide distribution of the disease, its high infectivity and its great virulence render it a serious menace to all countries in which poultry farming is extensively practised.

(v) Manninger's contention that the rapid serial passage of Newcastle virus through fowls reduces the period of incubation and gradually renders the infection indistinguishable from fowl plague, could not be confirmed.

Fowl pox (2).—The results obtained in recent investigations suggest strongly that the inclusion bodies that occur in fowl pox and psittacosis are in reality the causal agents.

It is now known that fowl pox can be transmitted by certain biting flies and mosquitoes; but it must not be forgotten that the disease is highly contagious in the absence of an insect vector, and transmission by direct contact is probably the most important mode of spread.

Immunisation with live virus has been extensively used in America, and has been proved to confer a solid immunity, usually life-long. It can only be used with any safety in young birds, and should not be applied to laying flocks, since vaccination always causes a marked decrease in egg production, and may be followed by a heavy mortality.

The use of pigeon-pox vaccine has given good results in Great Britain. It produces no constitutional disturbance and no decrease in egg production; nor is there any risk of the infection becoming generalised. On the other hand, the immunity conferred is not sufficient to protect the fowl against a severe artificial infection, although it gives a solid immunity against heavy natural infection, and the immunity lasts only for 4 to 6 months.

In view of the present seriousness of fowl pox, it is recommended that for the present all young stock should be inoculated annually with pigeon-pox vaccine.

Fowl cholera.—The investigation of this disease was continued, but the work had temporarily to be interrupted, owing to the claims of a more urgent problem.

Infectious laryngo-tracheitis.—This disease is a cause of very serious loss in North America, but until recently it had never been diagnosed in Great Britain, and the country was believed to be entirely free from it. In January, 1935, it was definitely diagnosed in specimens from a fattening plant. A considerable amount of work has since been carried out, including filtration experiments and a comparison with a strain of laryngo-tracheitis virus obtained from America.

From a mass of experimental data, the following conclusions have been made:—

(i) The disease does not appear to be caused by a visible organism; all microscopic and cultural examinations have been negative.

(ii) The filtrates obtained after passage of material through Berkefeld "V" and "N" filters, when inoculated intratracheally into healthy birds, reproduce the symptoms and lesions seen in the naturally affected birds.

(iii) Susceptible birds can easily be infected by the intratracheal inoculation of material taken from the trachea of an infected bird. The characteristic symptoms associated with this disease may be noticed within three days of the inoculation, and death may follow two or three days later.

(iv) Transmission by coop infection has been successful. Infected birds have been removed from coops, after exhibiting symptoms of the disease during a period of about 14 hours, and replaced by healthy birds. Some of these healthy birds have become typically affected and died, and post-mortem examination has revealed the lesions in the trachea.

(v) Transmission has readily occurred from the contact of infected and susceptible healthy birds in the same coop.

(vi) Birds solidly immune to fowl pox have acquired the infection when placed in contact with others affected with laryngo-tracheitis.

(vii) Birds immune to Newcastle disease have also acquired laryngo-tracheitis as a result of contact with the affected.

(viii) Birds which had recovered from the disease under investigation, when inoculated intratracheally with an American strain of infectious laryngo-tracheitis virus, showed no symptoms or lesions. Also no symptoms appeared in birds which had recovered from infectious laryngo-tracheitis caused by the American virus, when they were inoculated with material from the British outbreak. In both experiments adequate controls were included, and these birds exhibited typical symptoms and post-mortem lesions of infectious laryngo-tracheitis.

It has therefore been shown that the disease which was first detected in Norfolk is immunologically indistinguishable from infectious laryngo-tracheitis, as known in the United States of America.

Further investigations have shown that the disease is widely spread in the country; the losses may be quite trivial, but in a number of outbreaks, and particularly in fattening establishments, there may be serious mortality.

Titles of papers issued during the year.

1. Doyle, T. M.: The distribution of *Br. abortus* in the system of "carrier" cows. *J. Comp. Path. & Thera.*, **48**, 3, 192-217, 1935.
2. ———: Fowl pox. *Paper presented at the Twelfth International Veterinary Congress, New York.* August, 1934.
3. ———: Newcastle disease of fowls. *J. Comp. Path. & Thera*, **48**, 1, 1-20, 1935.
4. Taylor, E. L.: The treatment of gapes in chickens by mechanical removal of the parasitic worms. *Vet. Rec.*, **15**, 24, 692-693, 1935.
5. ———: *Syngamus trachea.* The longevity of the infective larvae in the earthworm. Slugs and snails as intermediate hosts. *J. Comp. Path. & Thera.*, **48**, 2, 149-156, 1935.
6. ———: Applied biology in the control of the worm diseases of domestic animals. *Ann. Appl. Biol.*, **22**, 1, 168-175, 1935.
7. ———: Parasitic gastritis: the causes underlying its development in sheep. *J. Min. Agric.*, **42**, 7, 647-657, 1935.
8. ———: Do nematodes assist bacterial invasion of the host by wounding the wall of the intestinal tract? *Parasitology*, **27**, 2, 145-151, 1935.
9. ———: An attempt to transmit anaplasmosis by British biting flies. *Vet. J.*, **91**, 4-11, 1935.
10. ———: Acute parasitic bronchitis in adult cattle caused by immature lungworms. *Vet. Rec.*, **15**, 1280-1284, 1935.

11. ———: Differential enumeration of the species of nematodes associated with parasitic gastritis in sheep and cattle. *Ibid.*, **15**, 1511-1514, 1935.

12. ———: Seasonal fluctuation in the number of eggs of trichostrongylid worms in the faeces of ewes. *J. Parasit.*, **21**, 3, 175-179, 1935.

13. Green, H. H., Allcroft, W. M., and Montgomerie, R. F.: Hypomagnesaemia in equine transit tetany. *J. Comp. Path. & Thera.*, **48**, 74-79, 1935.

14. Allcroft, W. M., and Green, H. H.: Blood calcium and magnesium of the cow in health and disease. *Biochem. J.*, **28**, 2220-2228, 1934.

15. Green, H. H.: Minerals in relation to disease of the larger domesticated animals. *Empire J. Exp. Agric.*, **3**, 363-378, 1935.

16. Allcroft, Ruth, and Green, H. H.: Rapid titrimetric estimation of arsenic in biological material. *Biochem. J.*, **29**, 824-833, 1935.

17. Dobson, N.: Infectious laryngo-tracheitis in fowls. *Vet. Rec.*, **15**, 774-775, 1935.

18. ———: Infectious laryngo-tracheitis in poultry. *Ibid.*, **15**, 1467-1471, 1935.

27. ANIMAL DISEASES RESEARCH ASSOCIATION, EDINBURGH

Tick-borne fever.—It is important to determine whether, in the event of sheep stock being removed from infected pastures, tick-borne fever " virus " can survive in ticks which engorged on ground vermin or on birds. It has been found that unfed infective nymphs, which were allowed to engorge on rabbits and guinea pigs, were capable, as adults, of transmitting the disease to sheep. It therefore appears that the virus of tick-borne fever can survive in ticks which feed on non-susceptible hosts.

Further experiments, designed to test the period of viability of the virus under different conditions, indicated that the virus is non-viable in glycerin, and, of three suspending media tested, isotonic saline, broth and plasma, the last appears the most suitable for its preservation. The optimum reaction of the suspending medium lies between pH 6·0 and pH 8·0.

In a limited number of experiments, it has been found that, following experimental infection, certain changes occur in the absolute number of the various types of leucocytes. The polymorphonuclear cells, after usually showing an initial rise, decrease in number, reaching their minimum count at about the tenth day, after which they show a gradual rise to normal, which is usually attained at about the fifteenth day. The eosinophil count falls at about the third day after infection and remains low until about the twentieth day, when it again rises to normal.

The lymphocytes, monocytes and basophils do not show any constant alteration in number.

Louping-ill.—Approximately 40,000 doses of louping-ill vaccine were issued this year. It was again found that the vaccine was capable of very markedly reducing the mortality incidence.

Braxy.—Approximately 51,000 doses of the " single-dose " anaculture vaccine have this year been issued. The vaccine continues to prove highly effective as a prophylactic.

Scrapie.—The systematic histological investigation of the tissues in scrapie, commenced in 1932, is now reaching completion. The nervous system, blood vascular system, lymphatic and endocrine glands, urogenital organs, skin and abdominal viscera, have been systematically examined. No constant abnormality has been observed, except in the case of certain cells in the medulla and cord, in which marked vacuolation occurs. The significance of this finding has yet to be determined.

The field experiment, set up for the purpose of testing the possibility that the contagium of scrapie might be transmitted through the medium of the pasture, has now been in progress for three years. The result, so far, has been negative.

The comparative incidence of *Sarcocystis tenella* in the muscles of scrapie and non-scrapie sheep has been observed. It has been found that, while in scrapie *Sarcocystis tenella* is generally more numerous than in healthy sheep, in debilitated sheep, suffering from chronic conditions other than scrapie, the parasite may be present in the muscles in much greater numbers than those which occur in that disease.

Grass sickness.—The intestinal contents of a large number of acute and sub-acute cases of grass sickness have been examined for the presence of toxins. It has been found that, in a small proportion of cases in which the examination was made during the early phase of the disease, the presence of the toxin of *Cl. welchii* type D (Wilsdon) could be demonstrated. The significance of these findings is under investigation.

Contagious bovine abortion.—With the object of assessing the comparative value of different types of prophylactic dead vaccines, a standard criterion of infection for the guinea pig has been worked out. Against this standard infection, six types of vaccine have been tested. In one group of vaccines, the organisms were destroyed by heat, and in the other they were destroyed by formalin. In each group, vaccines were prepared by using (*a*) infected guinea pig spleen as the basis of the vaccine; (*b*) a first sub-culture of *Br. abortus*; and (*c*) a 38th sub-culture of the organisms. A certain degree of immunity appeared to be afforded by the vaccines prepared from organisms derived from the first sub-cultures. The investigation is being continued and extended.

Enzootic abortion in ewes.—The field experiment, commenced in 1931-32 for the purpose of testing the possibility that enzootic abortion in ewes as it occurs in Scotland results from certain dietary deficiencies, have been repeated and extended. In these tests, vitamins and various chemical compounds have been administered, but, so far, no reduction in the abortion rate has been effected in the areas in which the disease is enzootic.

Pine.—There was reason to believe that a condition of " pining ", similar to that which we found to exist in the island of Tiree, was prevalent in areas in the mainland of Scotland. It has been found that such an area exists in Ross and Cromarty and that the administration of iron compounds proves of specific value in both the prevention and cure of the disease.

There is strong evidence that that form of pine which occurs in the Cheviot area results from dietary deficiency, and field experiments to determine the nature of the hypothetical deficient factor are now in progress.

Magnesium metabolism.—The twelve months' survey of the seasonal variations which occur in the blood magnesium of milch cows is nearing completion.

An investigation is now in progress for the purpose of studying the metabolism of magnesium by experimental observations on the rabbit and the sheep. The particular object of these experiments is to demonstrate *inter alia:*—(*a*) the effect which the varying intake of magnesium has upon its excretion; (*b*) whether magnesium is stored in the body in an available form; (*c*) the minimum magnesium intake which will maintain the animal in magnesium balance; (*d*) the fate of magnesium salts when administered orally and parenterally.

Titles of papers issued during the year.

1. Gordon, W. S.: Recent advances in the control of certain diseases of sheep. *Vet. J.*, **90,** 439-446, 1934.
2. MacLeod, J.: The part played by alternative hosts in maintaining the tick population of hill pastures. *J. Anim. Ecol.*, **3,** 161-164, 1934.
3. Wilson, J. E., and Wilson, D. R.: An outbreak of fowl cholera in Scotland. *Vet. J.*, **91,** 57-59, 1935.
4. Brownlee, A.: Diseases of sheep. *Agric. Prog.*, **12,** 118-123, 1935.
5. ————: A species of *Demodex* found in sheep in Britain. *J. Comp. Path. & Thera.*, **48,** 68-73, 1935.
6. MacLeod, J.: *Ixodes ricinus* in relation to its physical environment. II. The Factors governing survival and activity. *Parasit.*, **27,** 123-144, 1935.
7. Greig, J. R., and Dryerre, H.: Den specifike Kemoterapi for Kaelvningsfeber ved Hjaelp af parenteral Indgift af " Kalciumboroglukonate ". *Medlemsblad for Den danske Dyrlaegeforening*, **18,** 109-116, 1935. Reprinted in *Vet. Rec.*, **15,** 456-459, 1935.

28. VETERINARY RESEARCH DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

Abortion.—The work referred to in previous reports is being continued. Various methods of preparation of dead vaccines are being investigated.

Tuberculosis.—The report on the experiments with Spahlinger's anti-tuberculosis vaccine has been issued. The report states that ". . . . it must be concluded that a high degree of resistance or immunity against the massive dose of tubercle bacilli injected intravenously was conferred on the vaccinated animals."

Diseases of pigs.—Investigations into pneumonia in swine have been commenced and are being pursued as circumstances permit.

Titles of papers issued during the year.

1. Kerr, W. R., Lamont, H. G., and Shanks, P. L.: Methods used in the preparation of a new type of dead anti-abortion vaccine. *Vet. J.*, **91**, 306-308, 1935.
2. Kerr, W. R., and Common R. H.: The effects of certain acid treatments for coccidiosis on the H.-ion. content of the fowl's intestine. *Ibid.*, **91**, 309-311, 1935.
3. Lamont, H. G., Kerr, W. R., and Shanks, P. L.: Report on the Spahlinger experiments in Northern Ireland, 1931-1934. *H.M.S.O.*, Belfast, 1935.
4. Lamont, H. G.: Coccidiosis in bovines and poultry. *Nat. Vet. Med. Assoc. Cong.*, Belfast, 29th July-2nd August, 1935.

ANIMAL NUTRITION AND ANIMAL BREEDING

29. ANIMAL NUTRITION RESEARCH INSTITUTE, CAMBRIDGE UNIVERSITY

PHYSIOLOGY.

Cattle.—More sterile cows, sent to the Research Station by the owners, have been studied, and four cases have occurred which have not responded to physiological treatment. These were killed and their organs examined; two had a pathological condition of the uterus (pus accumulations) and two had anatomical abnormalities of the tract, probably caused by difficulties in calving. In conjunction with Professor Buxton, application was made for a pathologist to work on such cases, for they have also been found among the cows examined in local dairy herds during the course of the year.

Horses.—Growth studies of the Shetland-Shire crosses have been continued, and tests for the diagnosis of pregnancy in mares have been made.

Sheep.—Another attempt to obtain fertility in the non-breeding season by putting the sheep in complete darkness failed. Injection of pregnancy-urine hormone was then tried, and, although this caused ovulation (seen post-mortem), no heat was produced, and the ewes could not be served. Injection was then combined with artificial insemination, the semen being obtained from the ram by electrical stimulation of the ejaculation centre in the cord; one pole was inserted in the rectum and the other in the longissimus dorsi muscle at the level of the fourth lumbar vertebrae. This was done in July and so no results are yet available. An Ancon ram (short-legged) was imported from the Storrs Agricultural Experimental Station, Connecticut, U.S.A., to test its value for mutton production, but died during the wet weather in the winter. A study of its bones showed that the peculiar proportions are due to a localised effect on the metatarsals and metacarpals, and not to a general internal secretion effect on the growth of the bones as a whole.

Pigs.—An inbreeding experiment has been begun with two Large White litter mates obtained from the University Farm. Two strong healthy litters have been reared. In co-operation with the Low Temperature Research Station, the growth changes in the tissues have been studied on some of these, while others have been kept to breed future generations.

Rabbits.—Studies on the changes occurring during pregnancy have been continued. The investigation aims at discovering the factors (internal secretion or otherwise) responsible for the proper development of the young and the preliminaries necessary for an easy parturition. The cause of foetal degeneration has also been investigated. In the inbred stock a mutation affecting the length of the over-hairs has occurred. Breeding stock of a furless mutation has been sent to the Genetics Institution in Berlin for comparison with a similar mutation which has occurred there.

Milk and butter-fat secretion.—Investigations have been carried out on the colour of the butter fat, the variations in fat content and butter-fat ratio, milk pressure in the udder, and the development and evolution of milk composition.

Meat.—Studies on the proportions of the different tissues (muscle, fat and bone) required by the consumer in carcases of pork and bacon pigs, and how these vary in different breeds, weights, etc., have been made in connection with the New Zealand Government, and at various agricultural shows. The investigation on quality points in beef and mutton has been continued. Work in connection with this investigation on factors affecting the colour of body fat in rabbits has shown that concentration of the colour occurs on utilisation of fat by the body, thus partly explaining why butchers prefer pale, and not deep, yellow fat on beef carcases.

Wool.—Mr. L. Thomasset (of Uruguay and the Institut Agronomique, Gembloux, Belgium) has been working at the Institute for a short period on the variability in, and growth and development of, the wools of certain British breeds.

Artificial insemination.

Horse.—In order to provide more material for the study of the Shetland x Shire crosses semen has been collected at two private studs. Of the five Shetland mares inseminated three are believed to be pregnant. By kind permission of the University Farm, one of their Shire mares has again been inseminated with Shetland semen and is believed to be in foal. All these inseminations have been made within two hours of collection. Longer periods of storage have not been promising with untreated semen in spite of temperature control. This is thought to be due to the large dilution of the sperm with accessory secretions. Experiments on collecting separately the more dense portions of the ejaculate and centrifuging the semen with "dilutors" have shown improvement in survival of the spermatozoa.

Cattle.—More promising results of storage have been obtained with bull semen. Fertility in one case has been obtained after storage for three days, but other inseminations at this and longer periods (up to five days) have not been successful. Until therefore a higher percentage success can be obtained, the storage and transport of semen over longer intervals cannot be recommended for practical application, although further experimentation is indicated.

A number of cows and heifers at the National Institute for Research in Dairying, Reading, were artificially inseminated. Good results were obtained with fresh semen, but poor results with semen stored for more than 24 hours. One successful result was obtained after 48 hours.

As an empirical experiment, a number of cows and heifers which had been treated with iodine for vaginitis, but had not subsequently held to the bull, were inseminated on the University Farm. The results have been promising, the majority apparently having held to the insemination. This experiment may throw some light on the causes of sterility following vaginitis or metritis. It was observed that in the majority of these animals the cervix had become displaced from the normal position as a consequence of the infections; this would in normal service prevent the deposition of the semen in the vicinity of the os, whereas artificial insemination ensures the deposition of semen within the cervix.

Pregnancy diagnosis in the mare.—Data on the Kurosawa test (microscopic examination of cervical mucus) have been obtained. Positive results are obtained in early pregnancy and have diagnostic value, but " positives " have also been obtained in non-pregnant animals. The microscopic test would appear to have little advantage over the mucus consistency test, but may be used as confirmation of the latter, especially in the early stages of pregnancy.

Sperm production in the rabbit.—A large number of ejaculates have been collected by means of a " dummy " and artificial vagina from male rabbits. The volume of the ejaculate and the sperm content have been measured. Individual variability, breed and strain differences, the influence of interval between ejaculates, and seasonal variability, have been studied. A comparison between the number of spermatozoa in the ejaculate and in the male tract has been made with the object of correlating the number in the ejaculate with potential supply in the tract.

Heredity of hypospadias in the rabbit.—A number of female rabbits have been inseminated with sperm taken from the tract of males affected with hypospadias, therefore sterile to normal mating. A number of young have been obtained and will be used in further breeding experiments to determine the mode of inheritance of this defective conformation.

Other research work.

Butterfats.—The investigation of the relationship between milk secretion and butterfat secretion in the milk of Jersey cows is being continued. The English Jersey Cattle Club Register of Merit records (1,200 of them) form the main basis, but a parallel study of a similar nature is being made of the records of a single herd (about 900).

Growth rate of hair in cattle.—The small experiment to measure the growth rate of the long coat hairs in cattle was practically concluded. Patches of hair on four Dexters have been cut at monthly intervals during the past year and subsequent growth measured. Marked seasonal differences in both the rate of growth and the amount of follicular activity have been noted.

The Dexter bull-dog.—Observations on the nature of the bull-dog calf problem continue to be made. A skeleton of a bull-dog calf has been mounted and measurements and weights of the limb-bones of a long-legged Dexter (supposedly free from the bull-dog character) and a short-legged Dexter have been made. Investigation of 711 calving records shows that the average gestation period of a normal Dexter calving is between 284-287 days, whereas a bull-dog may be born any time between five months and nine months (23 per cent. at seven months). There appears to be no seasonal influence affecting the phenomenon.

CHEMISTRY.

A summary has been prepared of the new method for the determination of sugars. Existing methods depend upon the behaviour of the sugars in certain oxidizing systems. In each case the reduction values per unit weight of sugar are not uniform for different quantities of sugar, and an estimate is arrived at by interpolation in a series of empirically ascertained values supplied in the form of a table. Each method entails its special series of such values, and in most cases a considerable quantity of sugar must be present before reliability for the method is claimed. Different methods, however, applied to a definite quantity of sugar give somewhat divergent estimates.

For about a century workers have attempted to elucidate the lack of uniformity for different quantities, since the causes lie at the root of the great difficulty of dealing accurately with very small quantities, a matter of particular importance in studies of the significance of fluctuation in the small sugar content of blood, etc. By the new method the reduction value per unit weight of glucose is constant for all quantities of glucose from about 1 up to 100 mg. and further, and by a special device accurate estimates from 0 to 1 mg. may be made.

Apparently an almost unlimited amount of sugar may be oxidized in a standard manner in that quantity of fluid used in a sugar determination. The process therefore seems to afford a good opportunity for conveniently accumulating oxidation products from different kinds of sugar for comparative studies.

NUTRITION.

Nutrition of bacon pigs.—The first large-scale feeding trial designed (i) to elucidate the influence of high levels of protein intake on the rate of live-weight increase and on carcase conformation and quality, (ii) to investigate the relative merits of the individual-feeding and group-feeding methods of experimentation has been completed during the past year. The results are now being analysed. A second trial was begun in September, 1935.

Experiments were begun during September, 1935, on nitrogen and mineral metabolism in the bacon pig at different levels of protein intake.

Lucerne investigations.—These have now been brought to a conclusion.

Sheep nutrition.—The investigations into the capacity for consumption of sheep of varying live-weight and breed on pastures of varying quality were brought to a close with a series of grazing trials conducted during the spring and summer of 1935.

The investigations designed to secure data that will enable the feeding standards for sheep (at present of an admittedly tentative character) to be submitted to critical examination and revision were continued during the winter of 1935-36. This work entails a great deal of labour, but it must be continued until the results are numerous enough to enable safe conclusions to be made.

Kale investigations.—Investigations of the composition, digestibility and nutritive value of marrow stem kale and thousand-head kale were concluded in the spring of 1935 and the results are being worked out and analysed.

Pasture research. The influence of fertilisers on the carrying capacity of pastures.—The depression of productivity which was noted when, after five seasons of application, the use of sulphate of ammonia was discontinued, has been further investigated during the past summer (seventh season of work). The results, so far as they have been analysed, show that this depression of productivity is still noticeable even in the second year following the discontinuance of applications of nitrogen.

Studies of ruminant digestion.—Work on the "in vitro" action of cultures of cellulose-splitting bacteria on cellulose, hemicelluloses, hexose and pentose sugars, starch, etc. has been carried out.

In addition, a few experiments have been made on the changes taking place in the rumen of a sheep provided with a rumen fistula, the animal receiving a basal ration plus varying quantities of a given food constituent (e.g. starch, glucose, etc.), the rumen contents being sampled at a number of intervals after feeding. Technical difficulties have been encountered in this phase, such as the tendency of the fistula to close up some weeks after the operation: this particular difficulty has now, it is hoped, been overcome.

POULTRY GENETICS.

As in the previous year, attention has been devoted almost entirely to the improvement of the Cambar poultry. Silvers and golds were bred partly from pure stocks, and partly from cross-breds mainly using the Barred Rock cross. After culling, 230 pullets were put into the recording pens in the autumn of 1934. As before, birds were rejected as soon as it became evident that they would be unsuitable as future breeders, either by reason of small egg-size or of poor egg-score. While interesting experimental data are thus lost, this procedure makes the best use of limited accommodation.

The records of the 1934 hatched birds have shown no improvement over those of the previous year. To some extent this may be due to more attention having been paid to egg-size and colour in the breeding pens. This is reflected in there being a much lower proportion of birds rejected for small egg-size and in a substantial improvement in egg-size and colour generally. On the other hand, it may be that the limit of improvement under small scale conditions has now been reached. It is hoped during the coming season to establish colonies of Cambars at the National Poultry Institute at Harper Adams and elsewhere, with a view to multiplying existing stocks and so getting larger numbers for selection.

The introduction of " fresh blood " has been continued. A trio of Barred Plymouth Rocks from the U.S.A. was obtained in December, 1934, and from all three birds cross-breds have been raised. Day-old Campine chicks were obtained from the French source mentioned in last year's report and several good looking pullets have been reared during the season. Two recorded Brown Leghorn hens were kindly presented by the Institute of Animal Genetics, Edinburgh, from highly bred utility strain. The pullets from the Welsumer and the White Leghorn pens have been recorded during the season and the successful survivors will be bred from in 1936.

An interesting source of " fresh blood " has been a new importation from France called *"Les Marans"*. It is claimed by the importers of this breed that its table quality is unsurpassed and that it is characterised by large brown eggs. According to the breed standard the birds should be not unlike substantial " Scots-Greys ".

A cockerel was selected which, on inspection, appeared to be free from the dominant Black Extension gene, and homozygous for the sex-linked barring gene. Mated to Silver Cambar hens, he behaved, as anticipated, very nearly as a pure Silver Cambar cock. It would seem that by careful selection from the mixed types which now pass as *Marans,* it would be possible to establish this breed as an auto-sex-linking breed from the start.

Osteitis deformans.—The study of this defect, commenced last year, was continued. The results of breeding tests seemed to show that the malformation was hereditary, but that its genetics were complex: some birds were affected only slightly. It was decided not to pursue the investigation further.

POULTRY NUTRITION.

The analyses of 40 Light Sussex cockerels of the same age have been completed, and the data are now awaiting statistical analysis. The big variable is the fat content, the fat percentage in the moisture-free carcase varying from 10·18 to 34·18 in different individuals. On the other hand, the protein and ash percentages of the fat and moisture-free carcase are extraordinarily constant.

A joint investigation with the County Poultry Instructor for West Suffolk on the occurrence of faults in eggs has now been completed. The data upon which the results were based were collected during 1931-1934 and involved the individual handling and candling of 164,381 eggs. The main conclusions reached were:—

(i) The occurrence of a particular type of fault is associated with the individual bird rather than conditions of feeding and management.

(ii) Elimination of faults in eggs can most quickly be achieved by the intelligent use of the candling lamp by breeders, followed by the rejection as breeding stock of all birds laying faulty eggs.

A preliminary series of feeding tests has been carried out with the view of obtaining a comparatively simple basal diet for future growth studies with chicks. During this work the interesting fact emerged that in wheat offals the mechanical condition of the product plays an important part in determining its value for feeding. Thus, whereas ground wheat or bran are readily eaten by young chicks, weatings causes pasting in the mouth, thus preventing adequate food intake and assimilation.

From consideration of the fattening experiments carried out at Wye by the Southern Table Poultry Committee the following facts were obtained:—

(i) The amounts of starch equivalent required to produce 1 lb. live weight increase are less for cockerels than pullets of the same age.

(ii) More starch equivalent is required to produce 1 lb. live weight increase during cramming than during trough feeding.

(iii) The efficiencies of the foods used to produce gains during fattening rank in the following order:—Sussex ground oats, barley meal, maize meal.

The investigation on the effect of different oils on the hatchability of eggs has been discontinued, since both laboratory pen and incubator accommodation proved insufficient to provide results which were statistically reliable.

When even a low level of oil is included in the ration of growing chicks, significant chemical changes in the composition of the body fat take place. Evidence has been obtained which indicates that the unsaturated fatty acids tend to have a cumulative effect on the composition of the body fat, and this point is being further investigated. Since the food fat at a 5 per cent. level gave the desired information, the proposal to feed at the 12 per cent. level was abandoned.

Analyses of the body fat laid down on fattening rations containing different cereals, viz., maize, Sussex ground oats and barley, have been carried out, and the results indicated that under our experimental conditions, and with a 12-14 days fattening period (during November), the quality of the carcase of Light Sussex cockerels was not impaired by the inclusion of maize in the fattening ration, nor was the body fat undesirably soft. A repeat experiment has been carried out with younger birds during July, but analyses of these have not yet been completed. The answer to this problem is of importance to the Poultry industry in their search for cheaper substitutes for Sussex ground oats.

Forty-eight hours starvation did not produce any significant effect on the composition of the body fat, but presumably starvation was not sufficiently prolonged. It is proposed to study at some later date the effect of starvation until a given reduction in body weight has been obtained, when changes in composition may possibly have taken place.

CALORIMETRY.

The poultry calorimeter has now been perfected and the final tests show it to be a really satisfactory instrument from a physical point of view for the work it is proposed to do with it.

Preparatory to determining the comparative energy values of carbohydrate, fat and protein for fowls, it has been thought desirable that the maintenance requirement, fasting katabolism, metabolisable and nett energy should be determined for one biologically sufficient ration at varying planes of nutrition. This will supply valuable figures from which one may proceed later to experiments with the pure nutrients by the process of admixture, for super-maintenance conditions.

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30. ROWETT RESEARCH INSTITUTE, ABERDEEN

Nutrition and disease.—The study of the influence of the state of nutrition as determined by the diet on susceptibility to certain bacterial infections has been continued.

In an extensive series of experiments upon rats fed different diets, diseased rats suffering from *Salmonella* infection were introduced into colonies of disease free rats. Those colonies fed on an inadequate basal diet suffered a greater death-rate and a greater percentage infection among the survivors than rats of similar breeding fed the same basal diet supplemented with milk and green food. The factors in the dietary supplement responsible for this increased resistance of rats to *Salmonella* infection are under investigation.

Certain properties of blood, called the natural immune bodies, have a defensive power against bacteria and their poisonous products. The influence of diet on the strength of these natural immune bodies is being investigated in sheep.

Because of its docility and the relatively large amount of blood which can be withdrawn, the sheep is especially suitable for such inquiries. From earlier work at this Institute it is known that the strength of the natural immunity reactions is significantly less in the hill sheep on the Argyllshire farm of Garrochoran than in sheep of the same breed at Aberdeen. Sheep from Garrochoran have therefore been transferred to Aberdeen and are being fed on different diets in an endeavour to determine the importance, if any, of nutritional factors on the strength of natural immunity reactions.

On certain deficient diets lesions have been found to appear in the intestinal tract of rats. With the co-operation of the Professor of Pathology at Aberdeen University, a detailed histological study of these lesions is being made.

A study of the correlation of iodine intake and endemic goitre has been carried out, and is nearly completed. In connection with this work a study has been made of the effect of external temperature and the stage of digestion on the histological aspect and the iodine content of the thyroid.

The work in relation to the influence of calcium deficiency in the diet on the incidence of pregnancy toxaemia in ewes has been continued and concluded. The results indicate that calcium deficiency alone is not sufficient to produce this disease in breeding ewes.

Arising from this work by the analysis of the carcases of the new-born lambs and the placentas, it has been found that the total losses of calcium from the ewe, consequent upon lambing, average 124 grams of CaO; 111 grams of P_2O_5 and 5·2 grams of MgO. From data cited in the literature it is calculated that these losses average about 15 per cent., in the cases of calcium and phosphorus, of the ewe's total content of these elements. The results emphasise the importance of an adequate supply of calcium and phosphorus in the diet of the breeding ewe.

Blood composition.—The effect of large increases in the carbohydrate content of the diet of the growing sheep on the health and composition of the blood of the animal has been studied, particular attention being paid to the various forms in which calcium occurs in the blood. This work has been extended to cover a study of the partition of serum-Ca in various pathological conditions in both sheep and cattle.

The study of the influence of variations in the Ca intake on the yield and composition of the milk and composition of the blood of dairy cows has been continued. The work is now being conducted with dairy heifers in their first lactation and it is hoped to continue it for a period of two or three years.

Feeding experiments.—As a result of balance experiments with pigs and feeding experiments in which the chlorine and sodium intakes of growing pigs were varied, it is concluded that, provided the chlorine intake is sufficient to maintain the animal in positive chlorine balance, the response to further additions of chlorine, the form of salt or calcium chloride, to the diet on the general nitrogen and mineral metabolism, will depend to a large extent upon the individuality of the animal.

In connection with the feeding experiment being conducted on the Duthie Stock Farm to compare the effect of rearing calves upon raw and pasteurised milk, a study has been made of the composition of the blood of these calves at different intervals during the six months experimental period.

At the Duthie Farm the work on pasture conservation has been continued (16). Dried grass from Fifeshire fed to dairy cows had a beneficial effect on milk yield and colour of butter-fat. Further experiments will determine the optimum quantity to feed. Comparisons between swedes and cabbages for milk production showed that their values were in accordance with their chemical composition.

The joint work with the Colleges of Agriculture to determine the values of certain standard rations has been continued, and a report published (15). The Pig Recording and Litter Testing Scheme begun in collaboration with the North of Scotland College of Agriculture has proved a success, and is likely to yield results of economical value. Different daily levels of food allowances have produced results which show that careful rationing of the pig can save a considerable amount of food (14).

The joint investigations with the Research Department of the Ministry of Agriculture for Northern Ireland and Harper Adams Agricultural College on different levels of protein for fowls have been continued. Investigations in the relationship, if any, between diet and disease in poultry have been begun.

Pasture research.—At Garrochoran the feeding experiments with sheep have been continued on the lines described in previous reports. Experimental data collected over a period of years are yielding valuable information on the biology of hill sheep. It is apparent that while the feeding of minerals, vitamins and proteins, believed to be deficient in the pasture, has had a beneficial effect on the sheep, the benefits derived are not, under present conditions, sufficient to counterbalance the cost of the material and the many practical difficulties in artificially feeding hill sheep-stocks.

In the winter of 1935-36 dried grass will be fed to see the effect on the number of lambs born and reared. It has already been shown that an allowance of concentrates of similar composition has had nothing like the same effect in this direction as good arable winter grazing.

Other experiments.—In conjunction with the Macaulay Soil Research Institute an attempt has been made, by a series of pot and plot experiments to determine (*a*) whether applications of copper sulphate on grass land are likely to result in any increase in the copper or iron content of the herbage; (*b*) the safe upper limit in the amount or copper sulphate which can be applied without producing any detrimental effect in the yield of herbage.

In sheep, a preliminary study has been made of the incidence of mating in a flock of Grey Face ewes. Grey Face ewes were mated with the Oxford Down, the Suffolk Down and South Down, in order to assess the suitability of their progeny for early lamb.

Groups of store cattle were wintered under different conditions of housing and feeding. Results so far indicate that the most economical method is to give the minimum allowance of food and comfortable shelter with reasonable exercise outside.

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31. (CHEMICAL AND) ANIMAL NUTRITION DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

POULTRY

Chicken feeding experiments.—Further experiments were conducted on the form of leg weakness which is prevented by separated milk but not by cod liver oil. The findings of previous experiments that the use of fish meal as the sole protein supplement led to a lower incidence of the trouble than the use of soya bean meal were confirmed.

For complete control and for even growth in the chickens it was found to be necessary to use dried separated milk as well, whatever the main protein supplement. When the ration contained dried separated milk, fish meal gave but little better results in terms of growth than soya bean meal.

In an experiment with different levels of protein the feeding was adjusted so that each group received each day an equal amount of food per bird. Under these conditions better results were obtained from the high levels of protein than from the medium or low levels. Better pullets were obtained from the high protein group. The additions of 1½ or 3 per cent. $CaCO3$ to a ration of cereals plus 5 per cent. dried milk plus 9½ per cent. fish meal had adverse effects on the health of the birds and on the rate of growth. In an experiment with different combinations of cereals better growth and health resulted from the substitution of extra maize meal for Sussex ground oats. Good results were obtained from a ration rich in wheat meal and maize meal; but an increase in the amount of sharps in the ration did not give satisfactory results. The use of chopped raw ox liver in another experiment accelerated growth especially in the early stages. The inclusion of charcoal in the mash was not beneficial. A slight but possibly not significant increase in the rate of growth was obtained from the inclusion of flint grit in the mash.

Laying experiments.—Work on the protein requirements of the laying hen was continued. While the ration of cereals plus salt continued to give good results slightly better production was obtained from the use of small amounts of a mixture of protein supplements (fish meal, meat meal and soya bean meal). Further experiments showed that white or black limestone of a high calcium carbonate content, and oyster-shell grit were equally suitable as a source of lime for the laying hen. In another experiment extra bran and to a less extent extra maize meal in the laying mash gave superior egg production to Sussex ground oats.

In further experiments the use of mashes which included cooked potatoes again led to excellent egg production but food consumption was again excessive and uneconomic.

In an experiment in which grain was fed *ad libitum* and mash consumption limited to 1 oz. per head per day excellent results were obtained. The mash used for this group contained double the usual amounts of protein supplement and salt. Further work along this line has been commenced.

Protein balance experiment.—To supplement the field experiments concerned with different levels of protein for laying hens, a balance experiment has been commenced.

Mineral metabolism experiments.—The mineral metabolism experiment mentioned in last year's report has been completed. It was concerned with alterations in nitrogen metabolism which are related to the excretion of phosphorus at the time of shell formation. When heavy phosphorus excretion accompanies shell formation there is an increase in the excretion of ammonia nitrogen. This suggests that the excess phosphorus is excreted under these circumstances as ammonium phosphate via the urinary route.

Pullets receiving a ration containing 5 per cent. calcium carbonate displayed no heavy phosphorus excretion, and only slight changes in ammonia nitrogen excretion, in association with shell formation.

The data of the experiment are of interest in connection with the question of calcium and phosphorus reserves in the fowl and their availability for egg formation.

A further mineral metabolism experiment has now been commenced with a view to securing more direct information upon the situation and nature of calcium and phosphorus reserves in the fowl.

Serum phosphatase studies.—Observations and experiments on serum phosphatase in the fowl have been continued. In the course of this work an increase of serum phosphatase activity has been observed repeatedly in association with laying in birds believed to be normal and under good conditions. This increase has always appeared to be of very different extent in different birds. It is not yet possible to state whether it is strictly normal or due to some nutritional or other disturbance. Experiment failed to reveal any simple relation between serum phosphatase activity and intensity of egg production as gauged by trap nest records. An attempt to reduce the range of variation of serum phosphatase in laying birds by administration of Radiostol B.D.H. (Vitamin D) was unsuccessful. Limitation of calcium intake, however, led to a much greater increase in serum phosphatase than that observed in a control group receiving adequate calcium carbonate. Individual laying birds appeared to preserve serum phosphatase values of the same order over prolonged periods of egg production.

Serum phosphatase was shown to be greatly increased in chicks affected by rickets. It is possible that serum phosphatase activity may be a more sensitive indication of rachitic tendencies in chicks than determination of serum calcium, serum inorganic phosphorus or " tibia " ash.

Reaction of intestinal contents.—In the course of the work mentioned above observations were made on the hydrogen ion concentration of the intestinal contents of the fowl. The " normal " figures secured accorded with those reported by other workers, and it was also noted that the mechanism for maintaining the intestinal reaction constant appears to be very efficient. In conjunction with the Veterinary Research Division experiments were carried out to ascertain whether intestinal reaction was significantly affected by hydrochloric acid or buttermilk as administered in the usual routine treatment for avian coccidiosis. No such effect was observed, and it is considered that the efficacy of such treatment cannot be ascribed to alterations produced in intestinal reaction (1).

PIGS.

Feeding of young pigs.—Feeding trials are being carried out to compare the efficiency of additions of fish meal and extracted soya bean meal and a mineral mixture to a cereal mixture for the first ration for young pigs. The litters of ten sows are to be fed on each ration and a statistical analysis will be made of the growth returns.

Fattening pigs.—A feeding trial is in progress to compare the feeding value of pollards and ground wheat for fattening pigs. Two groups of pigs are being fed on each ration so as to compare wet feeding where the amount of food fed is controlled, with dry feeding *ad lib.* from an automatic feeder. Three trials have been completed and a further trial is contemplated before an analysis is made of the results.

Quality of bacon.—An experiment is in progress to examine the effect of different levels of maize meal in the ration on the firmness of back fat in the pigs.

Title of paper issued during the year.

1. Kerr, W. R., and Common, R. H.: The effect of certain acid treatments for coccidiosis on the H ion content of the fowl's intestine. *Vet. J.*, **91**, 309, 1935.

32. PIG HUSBANDRY RESEARCH STATIONS

(A) HARPER ADAMS AGRICULTURAL COLLEGE.

Four experiments have been completed during the year, of which three were comparisons of rations and the fourth a study of the influence of early pasturage upon rate of growth and carcase quality.

Autumn grazing tests.—Lots of 15 pigs were grazed for 4, 8 and 12 weeks respectively after weaning in the autumn of 1934. The average growth rates recorded by these Lots were inferior to that obtained with a similar Lot that was housed continuously after weaning. In a previous experiment carried out in the summer of 1933 grazing had proved advantageous. In neither case could any influence of the grazing carcase quality be detected.

Pure whale meat v. *commercial meat meal.*—The superiority of the protein of pure whale meat over the mixed (meat and bone) proteins of commercial meat meal that had been demonstrated in a previous experiment was confirmed in a second test.

Protein requirements.—The scale of optimum protein supply arrived at in the earlier experimental work of the Station was confirmed in a further test in which three different levels of supply were compared. Increase of protein supply beyond the Station " normal " had no effect either on rate of growth or leanness of carcase.

Dried separated milk v. *extracted soya meal.*—Replacement of soya meal to the extent of 50 per cent. in the standard rations of the Station by dried separated milk reduced slightly the average rate of growth and efficiency of food utilisation.

High protein rations for young pigs.—In a preliminary test with seven litters no improvement in growth rate was obtained by raising the protein supply to a high level from six to twelve weeks of age.

Title of paper issued during the year.

1. Crowther, C., and Wright, T. S.: The work of the Harper Adams College Pig Feeding Experimental Station. *Pig Breed. J.*, 1935-6.

(B) SOUTH-EASTERN AGRICULTURAL COLLEGE, WYE.

The feeding of the nursing sow and of the sucking pigs.—The results obtained during the winter 1934-35 indicate that dried milk has a special value as a constituent of the ration of a nursing sow.

It was found: (i) that piglings which whilst being suckled by their dams receive a supplementary ration consisting of cereal meals plus minerals make normal growth and are less liable to suffer from scour than those which receive a similar ration to which protein-rich foods are added: (ii) piglings which are reared in sties will drink water from the age of two weeks: (iii) that they will also drink barley water to which a " chemical food " is added and that piglings which received the latter from two weeks old made better growth and were less liable to suffer from anaemia than the no-treatment controls.

Feeding methods and carcase quality.—The inclusion of 60 per cent. of millers offals in the ration of a bacon pig from weaning to slaughter is liable to result in the production of soft fat.

A clearly marked diminution in the thickness of the back fat of bacon pigs was obtained by reducing the intensity of feeding during the second half of the feeding period.

Titles of papers issued during the year.

1. Fishwick, V. C.: New light on winter rearing of pigs. *Farmer and Stockbreeder,* 2885. 25th Dec., 1934.
2. ————: Lookout for worms. *Ibid.,* 734, 1st April, 1935.
3. ————: The management of growing pigs. *J. Min. Agric.,* **42,** 545-552, July, 1935.

33. NATIONAL POULTRY INSTITUTE

(A) National Institute of Poultry Husbandry, Harper Adams Agricultural College.

Chicken rearing.—An experiment was carried out to investigate the value of fold brooding and rearing of chickens in the control of coccidiosis. The results to date do not indicate that brooding and rearing in folds is more effective in the control of coccidiosis than other systems of rearing.

Egg production.—Work in progress on the requirements of the laying hen for proteins indicates that good egg production can be obtained under semi-intensive and intensive conditions with rations consisting of cereals plus 1 per cent. salt and oyster shell *ad libitum.* A protein balance experiment carried out with two birds on this ration gave results indicating that good egg production could be maintained over a long period without loss of body nitrogen. From the results obtained to date it would appear that good egg production can be maintained on rations containing much less protein than the accepted standards.

Experiments carried out with different levels of protein in the ration of laying ducks have given results similar to those obtained with laying hens.

Egg quality studies.—A candling survey of eggs produced on the plant showed that there is no correlation between the candling appearance of the egg and the methods of feeding and management and that the condition of " watery white " as measured by candling is an individual characteristic of certain birds. Observations made on watery white eggs as judged by candling have shown that the appearance of the egg white (as judged by candling) has no relation to the actual quality of the white. Eggs that appear normal on candling may have a high percentage of thin white and eggs that have a high percentage of thick white may be graded by candling as having watery white (1).

Table poultry.—Investigations have been made upon the rate of growth and economic return from chickens reared on high weatings and high maize meal rations. Birds reared on a ration containing 49 per cent. weatings and 20 per cent. maize meal gave a slightly lower rate of growth and much higher mortality than birds reared on a ration containing 49 per cent. maize meal and 20 per cent. weatings. Supplements of a Vitamin A rich concentrate did not improve the rate of growth or lower the high mortality.

Chickens fattened over a period of 20 days on a ration containing 95 per cent. barley meal made similar gains and utilization of food as chickens fed on rations containing 95 per cent. Sussex ground oats (2).

Table ducklings.—Experiments with pellet feeding in the production of table ducklings gave very satisfactory results. Compared with wet mash feeding, pellet feeding gave a significantly greater rate of growth and moderately reduced labour costs (2).

Turkey rearing.—Further investigations have been conducted on the control of blackhead in turkeys. Intensive rearing gave a good rate of growth and a low mortality (8 per cent.), whereas birds reared extensively gave a slower rate of growth and had a high mortality (36 per cent.) due to blackhead infection. Treatment of the infected birds by carbon tetra-chloride or a proprietary remedy did not prove of much value in controlling mortality.

Rabbit production.—The work on " rexing " normal furred rabbits is being continued with satisfactory results and the surplus products sold at approximately double the price of normal furred skins. Grazing of rabbits on grass runs has given as good growth results as rearing in hutches, with a considerable saving in food and labour costs.

Table rabbit investigations on fecundity, rate of growth and food consumption have been carried out with a number of different breeds and crosses. The best results have been obtained by crossing Flemish Giants with Angoras and White Beverens.

Titles of papers issued during the year.

1. Macdonald, A. J.: Egg quality studies. *Rep. 19th Ann. Poult. Conf.*, Harper Adams College, August, 1935.
2. McMurray, M.: Table poultry experiments. *Ibid.*
3. Wilson, W. K.: A general purpose rabbit hutch. *Rep. 7th Ann. Rabbit Conf.*, Harper Adams College, August, 1935.
4. ———: Incidence of rickets in rabbits. *Nature,* 136, September, 1935.

(B) REASEHEATH: CHESHIRE SCHOOL OF AGRICULTURE. (NORTHERN BREEDING STATION.)

Work has been continued along the three lines of experiments mentioned in previous reports, namely: (i) cross breeding v. pure breeding, (ii) production of a strain capable of withstanding continuous inbreeding, and (iii) inheritance of infertility in White Wyandottes.

(C) WYE: SOUTH EASTERN AGRICULTURAL COLLEGE (SOUTHERN TABLE POULTRY SECTION).

As the Intensive House was not completed until the late spring, it was decided to:—

(i) Carry on with the production of the " Country Chicken ".

(ii) Conduct preliminary experiments in the management of the new Intensive House, preparatory to the full experiments, which would start in the autumn of 1935.

(iii) Explore further the possibility of producing a marketable chicken of 2½ lb. weight.

The cross used for the production of the " country " chicken was the Light Sussex male on the Rhode Island Red female. This is one of the most popular crosses used in commercial work to-day. Good fertility, hatchability, and rearability were obtained. As its designation implies, the " country " chicken was only finished off by a term of trough feeding, and though it does not compare as regards quality with the " Surrey ", satisfactory prices were made when it was marketed at 17 weeks of age.

In the preliminary experiments carried out in the new Intensive House, a lot of trouble was incurred in the initial stages with feather picking and cannabalism. This was lessened by darkening one side of the cages with screens, and with the advent of the cooler weather, it entirely disappeared. Results obtained in the early rearing stages have been most hopeful, the average weight of chickens at 8 weeks of age being heavier than that of chickens reared in outdoor brooders, and the mortality less.

No satisfactory cross has yet been found for the 2½ lb. marketable chicken. For this particular trade to be a commercial success, it is necessary to have not only a quick growing, fine bone full breasted bird, that can be sold without conditioning, or after a short term of trough feeding only, but fertility, hatchability and rearability must also be satisfactory. Where the Old English Game male has been used, crossed with various table breeds, bad fertility and slowness of growth has been a characteristic feature, though at the same time a good marketable 2½ lb. chicken has been obtained. Old English Game cockerels have now been crossed with other breeds, and cockerels from these crosses mated to pure Light Sussex hens. The progeny from these matings are showing great promise carrying in the majority of cases white flesh and shanks. Fertility and hatchability are good with these crosses. It is hoped that along these lines the required type of small chicken may be obtained.

34. SMALL ANIMAL BREEDING RESEARCH STATION, CAMBRIDGE UNIVERSITY

During the past year the work has been concerned chiefly with the following matters:—

(i) Experiments to determine the linkage values of the various known sex-linked factors. Such mapping of the sex-chromosome is a necessary preliminary to any attempt to decide whether it contains a factor or factors affecting fecundity. For some of the sex-linked factors determinations have been made by workers in other countries, but since these are not always in harmony with one another the whole matter demands fuller investigation. This work has been going on for some years and is likely to go on for some years more.

(ii) Experiments concerning cream plumage colour. This is a new and distinctive colour in poultry and its genetics has been investigated during the past three years. It is probable that some account of these experiments will be published in the near future.

(iii) Experiments to form a new breed with automatic sex-linkage, such as the Cambar, but with the Brown Leghorn type of plumage as a basis instead of that of the Campine.

(iv) Experiments with ducks to produce a new type which can be used for sex-linkage in these birds. The new breed is similar to the Khaki Campbell except for the darker and distinct type of plumage which is correlated with a darker down. It is expected that it will be finally fixed in the coming season. Since it differs from the Khaki Campbell in but a single genetical factor it can always be used in conjunction with this well-established breed to give ducks which will in all respects be similar to pure Khaki Campbells. In other words it will afford the breeder a method of producing pure Khaki Campbell ducks by a sex-linked method.

(v) The work with rabbits has been mainly concerned with clearing up some puzzling features in connection with the heredity of various kinds of yellows. The genetics of this colour has proved to be curiously complicated, but the problems connected with it seem at last to be in a fair way to solution. Such knowledge is, of course, essential for the breeding of standardised shades in pelt production.

35. INSTITUTE OF ANIMAL GENETICS, EDINBURGH UNIVERSITY

Formal Genetics and Cytology

Formal Genetics.

During the year the study of the mutant characters of *Drosophila pseudo-obscura* has been continued and further linkage relationships determined. The first, third, fourth and fifth linkage groups have been defined (8).

The genetical studies of the budgerigar have been continued and a book on this subject, addressed particularly to the breeders of this bird which will certainly be used much more commonly for genetical experimentation, has been published (2, 32). The study of the " half-sider " in the budgerigar has been completed and the results of this investigation have been presented (9).

The long protracted study of the inheritance of educability in the rat is drawing to an end and the results of six years experimentation are now being prepared for the press.

The results of a five years' study of the Muscovy and Aylesbury cross, made for the purpose of investigating the cause of the sterility of the hybrid, have been prepared for publication.

Cytology.

In order to secure a better understanding of the mechanism underlying sex-linked inheritance and to demonstrate the physical basis of partial sex linkage, the behaviour of sex chromosomes during meiosis in marsupials has been studied.

Drosophila pseudo-obscura with its different geographical races provides excellent material for the study of the possible method of the formation of new species. It has been shown that amongst these geographical races there are to be found structural changes in the chromosomes and that these are primarily responsible for sterility in the hybrid.

A new inversion in *Drosophila melanogaster* discovered at University College, London, has been studied cytologically (18).

A study has also been made of chromosome behaviour in several plant and animal species, in an attempt to define those forces which are responsible for normal chromosome segregation (19). This work included a comparative cytological study of two *Crepis* spp. which have the same number of chromosomes but which differ slightly one from the other in respect of size. The cytological analysis of meiotic chromosome behaviour strongly suggests that the structural differentiation of chromosomes plays an important part in the evolution of this genus (17).

During the last few years the cross Muscovy x Aylesbury duck has been made. The F_1 individuals produced by this cross are sterile, and the cause of this sterility is being investigated cytologically.

GENETICS AND SEX PHYSIOLOGY OF THE FOWL.

The studies on the Brown Leghorn fowl have been continued and a number of investigations which have been continued during the last 10 years are now at last maturing.

Records of first cross hens, from females of the selected small egg strain by a male from the large egg strain, show that the offspring give an increase in egg size over that of their respective dams. This year these birds have been back-crossed to a male from the small egg strain and the performance of their progeny now attaining maturity, will, it is expected, provide evidence to show how the egg-size character behaves in inheritance. It is already manifest that the mode of inheritance of egg size is by no means simple. The practical difficulties involved in maintaining a sufficient number of sire's sisters' records in order to estimate the genetic possibilities of the breeding males has necessarily made such analysis somewhat troublesome.

No further instances of continuous laying amongst birds of a non-moulting strain have been encountered. This may possibly be explained by the fact that the sire used was only distantly related to the hens which have exhibited this character.

The selection of birds for egg production at an economic level over a number of years has been continued, using as the basis of this strain a female whose production for a period of four years averaged 196 eggs, her production in the fourth year being only 11 per cent. less than that of her first.

An inherited character, taking the form of a peculiar comb deficiency, that had been observed in the stock for a number of years, has now been made the subject of experimentation. This year the female offspring out of a mating, normal female × affected male, have been back crossed to their sire.

On the physiological side, the study of the female sex hormone on the plumage of the Brown Leghorn capon has been continued. It has been found that amongst a large number of the birds employed in this investigation there are distinct classes in respect of the degree of the reaction. Persistent individual differences in the magnitude of the response suggest the presence and action of genetic factors. Seasonal and body weight differences had no effect upon the response but age had a marked effect, immature birds giving a significantly lower reaction to the hormone (12).

By means of a modification of the technique of injection it has been shown that the female sex hormone can exert its effect directly on the secondary sexual characters.

Further studies on the male sex hormone have also been made. It has been shown that the amount of response of the comb of the capon is directly proportional to the logarithm of the dose of the hormone and it has been found that the amount and nature of the solvent influence the reaction but that the response to subcutaneous and intramuscular injections are similar as are also those of birds of widely different ages (13).

Exploiting the findings that emerged from the study of the local injection of the female sex hormone, the injection of male sex hormone was made directly into the comb of the capon, when it was found that a much greater response was elicited than when the same dose was injected intramuscularly. Thus it has been demonstrated in the case of both sex hormones that the action of the hormone on the sex characters is a direct one. If, however, the hormone is injected directly into the combs of intact birds, males and females, then whilst in the former case no response is obtained, in the latter a certain amount of comb growth is induced although this is less in extent than that obtained in the case of the capons (14).

It has been shown (11) that up to the time that corresponds to the onset of puberty in the female fowl there is an interrupted continuity between the lumen of the oviduct and the cloaca and that the obstruction is of the nature of a membrane occluding the mouth of the oviduct. The perforation of this membrane, which is necessary before the first egg can pass, is under the control of the hormone of the ovary.

The breeding stock of Brown Leghorns has been carefully selected for a period of some 10 years and complete records of production and of other attributes have been carefully maintained. Analysis of the figures for egg production for the last three years has shown that in 1934 some adverse influence was affecting annual egg numbers. This was reflected, not only in the records of pullets but also in birds of all ages. The cause of the factor has yet to be isolated.

The stock has been maintained completely free from any epidemic disease and the birds are very carefully bred and pedigreed. The result of this has been that there is now a widespread demand for these birds for research purposes, particularly those dealing with problems of disease.

ANIMAL HUSBANDRY.

The experiment devised to explore the possibility of the existence of sex linked factors concerned with milk yield, continues. The first of the experimental heifers out of the cross between beef and dairy strains are now completing their lactations. Preliminary results seem to indicate that those sired by a beef bull and out of dairy cows possess a greater capacity for milk production. The F_1 bulls have been mated to Ayrshire heifers.

At Shothead Experimental Farm and at the adjoining farm of Cockburn there are under observation five old bulls, three young crossbred bulls, around one hundred cows, and about one hundred and thirty young stock.

The records of the pig stock are being maintained. A detailed analysis of the progeny of eight boars, each of which has not less than eight recorded litters on the books, is being made.

RABBIT BREEDING.

A study of the causes of the coarsening of the wool fibres in the Angora rabbit with increasing age is being made.

A successful attempt by rigorous selection to produce a strong and vigorous strain of Rex rabbits has been completed. It has been possible, through the co-operation of private breeders, to study the new waved coat character found in the Rex. It is somewhat similar to Astrakhan and is not unlike the waved character of the mouse and rat: it behaves as a simple recessive to the usual Rex coat and appears only in the finest coated individuals. It is commonest in the brown coloured Rex and there seems to be some possibility of linkage between waved and brown. The moult of waved youngsters is peculiarly rapid, sometimes resulting in complete nakedness and in certain instances the development of the waved character is delayed until the individual is nearly a year old, whilst in others it is expressed when the rabbit is a few days old.

The study of the genetics of the Smoke Pearl, the Hyracks and the Golden Glavcot is being continued.

The Institute frequently receives rabbits exhibiting unusual coat colour conditions. A male recently received exhibited blue-black and white mosaic. It has been shown by extensive breeding experiments that this condition is not transmitted to the offspring of this animal, and that black and blue in the Dutch are allelomorphic. This rabbit is of peculiar interest in that the blue appears in an area that is normally white in the Dutch pattern.

WOOL RESEARCH.

This work is in process of being concluded.

MISCELLANEOUS.

A body, the size and shape of a cricket ball, was found in the afterbirth expelled following the birth of a crossbred calf. Examination proved it to be an abortive co-twin. The distribution of hair and pigment and the situation of a diminutive fore limb indicated that had this co-twin lived it would have had the same coat colour pattern as had the living calf. The main interest of this specimen, however, lies in the fact that in the complete absence of any endocrine apparatus the integument and particularly the hair follicles pursue a complete development, thus providing another illustration of the developmental autonomy of the hair follicle (6).

Studies on the physiology of pregnancy in the rat have been continued. A very interesting and peculiar effect upon the female rat produced by the administration of oestrin both to the pregnant and to the lactating rat has been described (15, 16). This would appear to be the first recorded instance of a demonstrable effect of oestrin on the foetus.

Titles of papers issued during the year.

1. Crew, F. A. E.: The role of medicine in the further evolution of society. The Lloyd Roberts Memorial Lecture. *Manchester Univ. Med. Sch. Gaz.,* Dec., 1934.
2. Crew, F. A. E., and Lamy, R.: Genetics and the budgerigar. *Budgerigar Bull.,* Dec., 1934.
3. Roberts, J. A. F., and Thomson, W. A. R.: An inquiry into the family incidence of acute rheumatism. *Ann. Eugen.,* **6**, 2-12, 1934.
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5. Bryden, Wm.: Some observations upon the mitotic and meiotic divisions in the Wistar rat. I. The effect of changes in temperature. *Cytologia,* **6**, 300-307, 1935.
6. Crew, F. A. E.: A case of abortive bovine co-twin illustrating the developmental autonomy of the skin and hair follicle. *Trans. Dynam. Devel.,* **10**, 295-297, 1935.
7. ————: Men in the teaching profession. *Scott. Schoolmaster,* **1**, 6-15, 1935.
8. Crew, F. A. E., and Lamy, R.: Linkage groups in *Drosophila pseudo-obscura. J. Genet.,* **30**, 15-19, 1935.
9. ————: Autosomal colour mosaics in the budgerigar. *Ibid.,* **30**, 233-241, 1935.
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11. ————: Perforation of the oviduct in the domestic fowl. *Trans. Dynam. Devel.,* **10**, 81-92, 1935.
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15. Hain, A. M.: The physiology of pregnancy in the rat: an hormonal investigation into the mechanism of parturition. Effect on the female rat of the ante-natal administration of oestrin to the mother. *Ibid.*, **25**, 131-143, 1935.
16. ———: An effect on the rat of ante-natal and post-natal administration of oestrin. *Edin. Med. J.*, New Series (IVth), **42**, 101-109, 1935.
17. Koller, P. Ch.: Cytological studies in *Crepis aurea* and *C. rubra*. *Cytologia*, **6**, 281-288, 1935.
18. ———: The salivary gland chromosomes in heterozygotes for Grüneberg's inversion. Appendix to Grüneberg's paper in *J. Genet.*, **31**, 182-183, 1935.
19. ———: The movements of chromosomes within the cell and their dynamic interpretation. *Genetica*, **16**, 447-466, 1935.
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21. Pickard, J. N.: Propaganda work and methods of education. *Harper Adams Utility Poult. J.*, **19**, 575-578, 1935.
22. Robson, J. M.: The action of oestrin on the mammary secretion. *Quart. J. Exp. Physiol.*, **24**, 337-344, 1935.
23. ———: The effect of oestrin on the uterine reactivity and its relation to experimental abortion and parturition. *J. Physiol.*, **84**, 121-132, 1935.
24. ———: The action of oestrin on the uterus of the hypophysectomised and of the pregnant rabbit. *Ibid.*, **84**, 148-161, 1935.
25. ———: The response of the uterus of hypophysectomised rabbits to extracts of the corpus luteum. *Ibid.*, **84**, 296-301, 1935.
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31. ———: Origin of variations within species. *Nature*, **135**, 69, 1935.
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36. CROP AND ANIMAL HUSBANDRY DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

Erection of experimental pig house.—An additional pig feeding house, built by direct labour on the farm, was completed during 1935. This house has been specially constructed for experimental work and will be available for nutritional experiments. Six feeding crates have been supplied in each pen for individual feeding of experimental animals. With the exception of feeding trough space and other minor alterations this house has been built on similar lines to the large fattening house which was completed in 1933.

Sheep breeding.—A sheep breeding experiment was commenced in 1934 with the object of comparing different crosses for the production of butchers' lamb. The selected crosses are being confined to existing breeds in Northern Ireland. Previous to mating in the autumn of 1934 the ewe flock was divided into two groups, each comprising 22 Crossbred and 22 Blackface ewes, and mated respectively with a Border Leicester ram and a Suffolk ram. Records are being kept of the fertility and fecundity of the respective crosses, the weight of lambs at birth and at weaning, and, as far as possible, the weight of lambs and carcase quality when sold to the butcher.

H

DAIRYING

37. NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING

In the academic year 1934-5, though " ad hoc " investigations have not been neglected, much of the research work of the Institute has centred round a limited number of major problems of a more fundamental character amongst which are the following:—

The control of the compositional quality of milk.

The enzymes of milk and of the mammary gland.

The nature and control of cheese ripening.

Considerable progress has been made with the first of these problems, and that along several lines. (i) Analytical methods have been worked out in the past three years for the more rapid and reliable determination of certain of the constituents of milk, and this work has been pursued again in 1934-5. (ii) The blood constituents in relation to milk secretion in the cow have been studied by new methods and conclusions of importance have been reached. (iii) It has been found possible to improve both the fat and the solids-not-fat content of milk by additions of specific substances to the diet, or by parenteral administration of specific substances. (iv) A serious attempt to attack the practical problem of low-quality milk is being made.

With regard to the enzymes of milk and of the mammary gland, two of which have been investigated in some detail during the past year, it has been found necessary to devise new technique. One of the enzymes has been shown to be of value in the control of market milk.

In the difficult field of the control of cheese ripening, progress has been made with Cheddar cheese and with Stilton cheese. Once again it has been found necessary to devise new methods of attack; some have proved useful or promising, some unsuccessful. Certain of the organisms and enzymes which play a part have been studied. New knowledge has been acquired of the changes occurring in Cheddar and in Stilton cheese ripening, and progress towards the more exact assessment of flavour and quality is being made.

Control of the Compositional Quality of Milk.

Chemical investigations.

Analytical.—Methods in general use for the industrial control of milk quality are by no means satisfactory. Several of these methods have been under revision during the year, in co-operation with the National Physical Laboratory and the scientific staff of the leading dairy companies. Standardisation of glassware and methods has been necessary in a number of cases. A new, rapid technique for the direct determination of total solids in milk has been developed. The efficiency of the air-damped balance has been investigated in conjunction with the Physics Department of the University of Reading. Much attention has been paid to the detailed composition of normal milk (24). Figures for nitrogen distribution, chloride, copper and iron content are in the press. The relation of sodium to chlorine in milk has been considered (28), Particular attention has been paid to criteria of normality in milk, and advance in this field has enabled a study of the compositional quality of abnormal milk to go forward.

Control of taints.—Work has been continued on the fishy taint in milk which sometimes occurs when beet by-products are fed. The action of heat during the drying of molassed beet pulp is believed to bring about the production from betaine of an isomer (methyl dimethylaminoacetate). This substance, like betaine, choline, trimethylamine and trimethylamine oxide, gives trimethylamine oxide as its main nitrogenous metabolite in the cow. The action of the last substance on milk fat has been investigated.

Low-quality milk—causes and control.—The extent and severity of the phenomenon of milk low in solids-not-fat is being surveyed in several parts of the country, in an endeavour to correlate its occurrence with controllable factors. This entails not only careful examination of farms and of depôt records, but also much laboratory work.

Control of vitamin content of milk.—Experiments with lactating cows have shown that when cacao shell (an inexpensive by-product of the cocoa industry) is fed during the winter months to such animals in quantities of 2 lb. per day, the vitamin D content of the milk is raised to the summer level.

The vitamin D content of butter from the milk of Guernsey and of Shorthorn cows under identical conditions of feeding and management has been determined. Per pound of milk, Guernsey cows were found to produce 1·7 times as much of the anti-rachitic vitamin as Shorthorn cows.

Work has been done on the destructive effect of light (even through glass bottles) on the vitamin C of milk (5). The relative biological efficiencies of the vitamin A and carotene of butter (6) have been determined.

Physiological investigations.

The hormonal control of milk quality.—It has been found possible to improve, within limits, both milk quantity and milk quality by either thyroid gland feeding, or administration of thyroxin. When the hormone was given after the peak of lactation, both the fat percentage and the solids-not-fat percentage were increased in the milk, and there was also a marked increase in milk volume, giving a considerably greater percentage increase in total solids (25).

The relationship between blood constituents and milk constituents.—A new and very useful method for obtaining simultaneous arterial and venous blood samples from the cow has been devised, and by means of it further information has been obtained as to the mechanism of mammary synthesis. The results obtained strongly support the view that lactose of milk is derived from blood glucose, that the phosphorus compounds of milk arise from the inorganic phosphate of the circulating blood (and not from the phosphoric esters, as had been supposed) and that the milk fat is derived from the neutral fat of the blood and not from the phosphatides. Information as to the rate of blood flow through the active gland has been obtained, and interesting correlations observed between the level of the blood constituents and the rate of milk secretion (18, 19, 43).

Husbandry investigations (1, 2).

Effect of drought conditions.—It has been found, in the mixed milk of our own herd, that drought conditions are associated with marked lowering of non-fatty solids. Several factors may be at work, and an endeavour was made to decide what part, if any, high environmental temperature played in bringing about this lowering. Two cows were housed in an artificially heated room at about 80° F. and two controls kept under normal housing conditions. After a few weeks under these conditions the two groups were changed over. A statistically significant lowering, due to the effect of high temperature, was observed in this experiment.

The large demands made by the mammary gland on the carbohydrate of the arterial blood, suggested the possibility that high carbohydrate feeding might improve the low solids-not-fat content of milk during the summer drought. In a preliminary experiment 3 to 4 lb. of molasses were fed daily, in addition to the ordinary food, to each cow in a group of 14 cows without any significant change in the compositional quality of the milk.

Effect of additional fat in the ration.—The effect on the composition of milk of the addition of butter fat to the normal diet of a group of cows has been studied. Twelve cows divided into six pairs were used. One animal of each pair was given 1 lb. butter daily during the experimental period. These followed (*a*) a slight but not significant increase in the milk yield, (*b*) a significant increase of about 0·3 per cent. (i.e. 0·3 parts per 100 grams milk) in the fat content of the milk, the effect being more pronounced with Guernseys than with Shorthorns, (*c*) no change in the solids-not-fat content of the milk.

Effect of milk machines.—A comparison of the lactation records of two groups of cows (84 cows in each group) over a period of 8 years has shown that machine-milking is associated with slightly lower yields, but that there was no difference in the compositional quality of the milk as between hand and machine milking (2).

ENZYMES OF MILK AND OF THE MAMMARY GLAND.

Lipase in milk.—A satisfactory technique for the estimation of the lipase of milk has been evolved and is being applied to the milk of individual animals of the Institute herd in an endeavour to correlate changes in lipase content with different physiological conditions in the cow.

Phosphatase in milk.—This enzyme has received further attention during 1934-35 and a simple technique has been evolved, based on the fact that this enzyme is just completely destroyed during the holder process of pasteurisation, for controlling the efficiency and otherwise of this process (29). The method has been applied to the " pasteurised " milk sold in various towns and rural districts in Southern England and has given somewhat disturbing findings (30).

Phosphatase of the mammary gland.—Mammary tissue has been found to be relatively rich in this enzyme, which has been shown to be identical with the " alkaline " phosphomonoesterase of kidney and bone (16). The properties of the enzyme have been studied in relation to its possible synthetic activity in milk formation.

Phosphatase in the blood of dairy cows.—The possible relation between serum and milk phosphatases has been investigated. A new technique for the determination of this enzyme in the serum has been developed (17), and endeavours, so far unsuccessful, to correlate the fairly wide variations from cow to cow, in serum phosphatase with either disorders of Ca and P metabolism, nutritional differences, or differences in thyroid activity have been made. (In the human, the level of serum phosphatase is well-known to be of value in the diagnosis of certain bone disorders.)

THE NATURE AND CONTROL OF CHEESE RIPENING.

Lactic acid bacteria.—Further progress has been made during 1934-35 in the typing and identification of a large number of strains of lactic acid organisms of various types, both isolated from natural sources by the Institute or received from other bacteriological laboratories throughout the world. Special media have been devised and used in this work (13). There is reason to believe that some of the most economically important types are animal saprophytes or plant strains which have adapted themselves to rapid growth in milk and milk products.

Ripening of hard cheese.—The flora of Cheddar cheese, made from milk of certified quality, has been shown to consist almost exclusively of *Streptococcus lactis* and *cremoris*, and *Streptobacterium casei* and *plantarum*. Some of the factors controlling this flora have been determined (12). The work mentioned in the 1933-34 report on degradation of proteins of cheese by enzymes has been continued, and further work in this connection has been published on the nature of the proteolytic enzymes in rennet (11, 14, 15).

Quantitative methods for measuring cheese quality.—Methods for the scientific grading of cheese are being developed. At present cheese grading is an empirical procedure, but many of the characteristics used in grading are capable of quantitative measurement.

The rate of colour change in the quinhydrone used in the determination of hydrogen ion concentration of cheese has been found to be correlated with ripeness.

The assessment of flavour is also being considered, and a new method for the colorimetric estimation of free fatty acids in cheese (which acids have a marked influence on flavour, particularly in the mould-ripened cheese) is being worked out.

A method for the micro estimation of acetoin and diacetyl has been developed (10).

CHEMISTRY.

Nutritional and metabolic work.—In extension of the earlier work at this Institute which first demonstrated that pigs required large amounts of Vitamin A, the length of time during which a single dose of Vitamin A concentrate will persist in the liver of growing pigs is being investigated. The Weybridge laboratory of the Ministry is collaborating, and the necessary histological work is being undertaken at King's College (London) (22, 23).

Metabolic studies on rats are being carried out to elucidate the significance of the discovery that, in cow's milk, part of the antirachitic effect is not due to vitamin D (in the strict sense) (32).

A study of the nature of beryllium rickets in rats has also been undertaken (31).

Autoxidation of butterfat.—The part played by diacetyl in inducing deterioration in butterfat has been investigated. It has been shown that diacetyl is a potent autoxidative catalyst, apparently more potent than oleic acid, in inducing changes in butterfat spread over a surface (10).

Base-exchange in milk.—The use of zeolites as laboratory reagents for the examination of the kations in milk has been extensively investigated by two methods, and it has been found that all the calcium of milk does not behave uniformly towards zeolite. The work is still in progress.

BACTERIOLOGY.

Bacteriology of milk.

Characterisation of saprophytic streptococci.—Attempts have been made during the year by the preparation of appropriate precipitating sera to remove the confusion that exists in the group of streptococci which includes the so-called *S. lactis, S. faecalis* and other streptococci associated with milk and dairy products.

The effect of hydrogen ion concentration of milk upon the destruction of tubercle bacilli by heat has been determined, and follows the same course as that of the destruction of saprophytic bacteria which are commonly found in milk (41).

High-temperature short-time pasteurisation.—Studies of the performance of different types of apparatus for the carrying out of this process have continued during the year, and valuable data forming a basis for the assessment of the relative value of different types of plant have been secured (37).

Testing milk for bovine tuberculosis.—The use of a single guinea pig instead of two has been shown, by statistical examination of records obtained here over a number of years, to lead to misleading results in a large proportion of cases.

Survival time of bovine tubercle bacillus.—Further studies on the survival time of the bovine tubercle bacillus in soil, soil and dung, on grass, etc., together with the results of feeding infected grass to guinea pigs and calves have been made (35).

The plate count of milk.—Certain experimental errors in conducting plate counts of bacteria in milk have been considered (40).

Brucella abortus infection in the Institute herd.—During the year a number of cases have occurred in which abortion has taken place in cows giving a negative agglutination test. In each case the organisms have been recovered in pure cultures from the foetus or from vaginal discharges. The number of such cases is a substantial fraction of the total number of abortions.

HUSBANDRY.

Inheritance of milking qualities.—The collection of further information is proceeding. Yield, fat and solids-not-fat content of the milk produced by the daughters of the different bulls used in the Institute herd is being determined.

Winter feeding of young dairy cattle.—Two groups of yearling heifers (five in each group) were given a winter ration supplying the quantities of starch equivalent and protein equivalent complying with a normal feeding standard, and two other groups of similar heifers were given rations which were 10 per cent. below the standard. Satisfactory growth was obtained in all cases, but further experiments must be conducted before changes in the standard can be advised.

Sprouted barley as food for pigs.—The possibility of feeding young pigs on sprouted barley was studied. The recommended rations of sprouted barley alone (given long or minced) or a mixture of two parts sprouted barley and one part bran did not constitute a satisfactory feed for pigs 10 to 14 weeks old. When a balanced meal mixture was given, with sprouted barley in addition according to appetite, better results were obtained.

Titles of papers issued during the year.

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2. Bartlett, S., and Huthnance, S. L.: The influence of milking machines on milk yields. *Agric. Prog.*, **12,** 144-147, 1935.
3. Booth, R. G., Golding, J., Kon, S. K., Dann, W. J., and Moore, T.: A new spectroscopic phenomenon in fatty acid metabolism. The conversion of “ pro-absorptive ” to “ absorptive ” acids in the cow. *Biochem. J.*, **29,** 1, 138-146, 1935.
4. Booth, R. G., Henry, K. M., and Kon, S. K.: A note on the availability of phosphorus in experimental rachitogenic diets. *J. Soc. Chem. Ind.*, **54,** 12, 270, 1935.
5. Booth, R. G., and Kon, S. K.: Effect of light on the reducing substance (vitamin C?) in milk. *Nature,* **134,** No. 3388, 536, 1934.
6. Booth, R. G., Kon, S. K., and Gillam, A. E.: The relative biological efficiencies of the vitamin A and carotene of butter. *Biochem. J.*, **28,** 6, 2169-2174, 1934.
7. Booth, R. G., Kon, S. K., *et al:* A study of seasonal variation in butter fat. II. A seasonal spectroscopic variation in the fatty acid fraction. *Ibid.*, **29,** 1, 133-137, 1935.
8. Christian, M.I.: The derivation of asporogenous variants of a spore forming organism. I. Colony forms and serology. II. Cytological observations. *Zbl. Bakt.*, **2,** 92, 261-272, June, 1935.
9. Davies, W. L., and Strachan, J.: Vegetable parchment and wrapping materials for food. *J. Soc. Chem. Ind.*, **53,** 46, 973-975, 1934.
10. Davis, J. G.: The micro estimation of acetoin and diacetyl. *Soc. Agric. Bact.*, 1934.

11. Davis, J. G.: Slow starters in cheesemaking. *Agric. Prog.*, **12**, 138-144, 1935.
12. ———: Studies in Cheddar cheese. IV. Observations on the lactic acid flora of Cheddar cheese made from clean milk. *J. Dairy Res.*, **6**, 2, 175-190, 1935.
13. ———: The use of special litmus milk media for the diagnostic culture of lactic acid bacteria: (1) dextrose litmus milk, (2) yeast extract litmus milk, and (3) yeast extract dextrose litmus milk. *Ibid.*, **6**, 2, 121-124, 1935.
14. ———: Some biochemical aspects of cheese-ripening. *J. Soc. Chem. Ind.*, **54**, 27, 631-635, 1935.
15. Davis, J. G., and Davies, W. L.: The nature of the proteolytic enzymes in rennet. *Ibid.*, **53**, 51, 1083, 1934.
16. Folley, S. J.: The phosphatase of the mammary gland. *Ibid.*, **54**, 4, 86, 1935.
17. ———: A modification of the King and Armstrong method for estimation of phosphatase. *Ibid.*, **54**, 12, 272, 1935.
18. Folley, S. J., and Peskett, G. L.: Experiments on variations in blood composition. *J. Physiol.*, **82**, 4, 486-495, 1934.
19. ———: The effect of salts on cell permeability as shown by studies of milk secretion (contd.). *Proc. Roy. Soc. Lond.*, B, **116**, 799, 396-402, 1934.
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21. Golding, J.: The nutritive value of milk. *Surrey Milk Rec. Soc. Handbook*, 35-36, 1935.
22. Golding, J., and Foot, A. S.: Avitaminosis A in pigs. *Agric. Prog.*, **12**, 123-126, 1935.
23. ———: Value of dairy products (in pig feeding). *Farmer and Stockbreeder*, No. 2369, suppl. viii-ix, 4th March, 1935.
24. Golding, J., Mackintosh, J., and Mattick, E. C. V.: Investigations on the milk of a typical herd of Shorthorn cows. II. *J. Dairy Res.*, **6**, 1, 6-25, Jan., 1935.
25. Graham, W. R.: The action of thyroxine on the milk and milk-fat production of cows. *Biochem. J.*, **28**, 1368-1371, Oct., 1934.
26. Hiscox, E. R.: A coliform organism isolated from milk. The effect of temperature on the fermentation of lactose. *J. Dairy Res.*, **5**, 3, 233-235, Sept., 1934.
27. ———: Spore bearing bacteria in milk. *Soc. Agric. Bact.*, Papers, 1934.
28. Jones, T. S. G., and Davies, W. L.: The relation of sodium to chlorine in the milk of Shorthorn and Guernsey cows. *Biochem. J.*, **29**, 4, 978-981, Apr., 1935.
29. Kay, H. D., and Graham, W. R.: The phosphatase test for pasteurised milk. *J. Dairy Res.*, **6**, 2, 191-203, May, 1935.
30. Kay, H. D., and Neave, F. K.: Some results of the application of a simple test for efficiency of pasteurisation. *Lancet*, No. 5835, 1516-1518, 29th June, 1935.
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32. ———: A note on the phosphoric ester content of the red cells and liver, and the phosphatase of the kidney in experimental osteoporosis in young rats. *Ibid.*, **28**, 4, 1228-1229, Oct., 1934.
33. Kay, H. D.: The biological significance of milk. *Biology*, **1**, 67-73, 1935.
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35. Mackintosh, J.: Dairy farming and dairy work. *J. Roy. Agric. Soc.*, **96**, 114-141, 1935.

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37. Mattick, A. T. R.: Oxidation-reduction potentials of milk bacteria and their influence upon oxidations produced by copper (oiliness in milk). *Soc. Agric. Bact.,* Papers, 1934.

38. ———: Progress in pasteurisation. The high temperature short time process. *Milk Industry,* **15,** 7, 81-85, Jan., 1935.

39. ———: Factors affecting the hygienic quality of milk on delivery to the consumer. *J. State Medicine,* **42,** 10, 614-620, Oct., 1934.

40. Mattick, A. T. R., and Hiscox, E. R.: The need for amplification of the methods of testing for coliform organisms in milk. *Agric. Prog.,* **12,** 136-137, 1935.

41. Mattick, A. T. R., Irwin, J. O., McClemont, J.: The plate count of milk. Experimental errors in the examination of I (*a*) different portions of the same sample by the same person, (*b*) different portions of the same sample, by two different persons in one laboratory and II, different portions of the same milk by ten persons in ten different laboratories. *J. Dairy Res.,* **6,** 2, 130-147, May, 1935.

42. Mattick, A. T. R., and Nichols, A. A.: The effect of the reaction (pH) of milk on the destruction of micro-organisms by heat. *Ibid.,* **6,** 2, 125-129, May, 1935.

43. National Institute for Research in Dairying: The Spangenberg process of sprouting maize for fodder. *Int. Rev. Agric.,* **26,** 2, 62-86 T., Feb., 1935.

44. Peskett, G. L.: Milk secretion in relation to blood composition. The urea contents of blood and of milk-serum. *Biochem. J.,* **28,** 5, 1657-1658, Nov., 1934.

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38. HANNAH DAIRY RESEARCH INSTITUTE.

Nutrition.—In past reports reference has been made to investigations designed to demonstrate the difference in the nutritive value of various proteins for milk production. This work has now been extended to cover the maintenance requirements of dairy cattle. It has been shown that the requirements for tryptophane, cystine, arginine and histidine are minimal, while the lysine requirement approximates 4 g. per 1,000 lb. body weight (1).

In connection with the calculation of biological values, it has been necessary to re-investigate the level of metabolic faecal nitrogen in the ruminant. Extensive series of feeding experiments have been carried out and these show that the metabolic faecal nitrogen approximates 0·35 g. per 100 g. dry matter intake. In addition, an investigation has been made into the digestibility of different foodstuffs fed at varying levels and containing proteins of markedly different quality. The results of these two investigations will shortly be published.

Lactation.—In the last report reference was made to the differences which have been found between the composition of arterial and venous blood. It was suggested that these differences were largely due to the intervention of the salivary glands. In order to investigate this point more fully, pilocarpine has been administered to a number of animals with the object of stimulating salivary secretion. The results indicate that the original suggestion is correct (2).

In connection with the study of milk secretion it has been necessary to devise a suitable method for the micro-estimation of lactose in milk. Excellent results have been obtained by the modification of the well known Hagedorn-Jensen ferricyanide reduction procedure (3).

Special attention is now being given to the study of fat secretion. As a preliminary, extensive investigation has been made into the levels of various fatty constituents of the blood during fasting and realimentation. The work has been extended to include a study of nitrogen, calcium and phosphorus metabolism during fasting and realimentation.

Grass conservation.—In order to enable accurately controlled metabolism experiments to be carried out with fresh herbage and with the dried product, the Agricultural Research Council have placed at the disposal of the Institute a commercial grass drier. The necessary feeding trials have now been completed. They show that, so far as the nutritive value of the product is concerned, there is no significant difference in the quality of the fresh and dried grass. There is, however, a marked difference between the biological values of the proteins of spring and autumn grass, and this is apparent in both the fresh and the dried product.

Similar tests have been carried out to determine the nutritive value of the three main types of grass silage, i.e., ordinary silage, molasses silage, and A.I.V. silage. These trials also show that there is no difference between the nutritive value of the proteins of the fresh and of the ensiled grass, and that the method of ensiling does not affect the product. It was, however, observed that the cows appeared to lose condition after prolonged feeding on the grass silage.

Careful studies have been made during the past four years of the yields of young grass which can be obtained from experimental plots under different systems of manuring. The results indicate that the yields of intensively fertilised plots are liable to fall off seriously unless they are given a dressing of dung. In view of the importance of this finding the experiments are being continued for a further period.

Bovine Tuberculosis.—In 1929-32 a small-scale eradication scheme was carried out in part of Ayrshire, based on the provision of free tuberculin testing and free expert advice on isolation methods (4). In 1935 the area was re-surveyed to discover how far the promising results obtained had survived the cessation of the free facilities. It was found that the extent of infection had been still further reduced: only five herds out of 30 showed no improvement since the termination of the scheme, and there were herds in which eradication would be abnormally difficult . Further, the practice of tuberculin testing has spread from the experimental area outwards: within a five-mile radius of the centre of the experimental area nearly 30 per cent. of the herds are now free from infection, and 60 per cent. of owners have had their stock tested.

Bovine Mastitis.—Hitherto all work has been greatly hampered by the lack of methods of diagnosis, which are now available. Experiments are in progress to discover the best means of controlling the disease in dairy herds, and various curative treatments are also being investigated.

Technical Research.—In the last report reference was made to the effect of heat in causing a cleavage of phosphorus from the casein molecule. This work was originally carried out at temperatures approximating 120° C. The investigation has now been extended to include temperatures varying between 90° C. and 120° C. The results fully confirm the findings already published, but they indicate that phosphorous cleavage is unlikely to be an important factor in technical problems such as the heat coagulation which occurs in evaporated milk.

Investigations have also been continued into various defects which occur in canned milk products. A special study has been made of the occurrence of " bitterness " in canned cream. A number of strains of the responsible organism have been isolated, and these have been re-inoculated into sterilised cream. It has been possible to reproduce the defect and to study the process of breakdown during development of the bitter flavour. An investigation has also been made into the heat resistance of the organisms concerned.

The Institute has been provided with a complete range of small-scale processing equipment for dealing with canned milk products. This will enable the various laboratory findings to be tried out under practical working conditions.

The survey of pasteurising plants in the four Scottish cities has now been completed (5).

Titles of papers issued during the year.

1. Morris, S., and Wright, N. C.: The nutritive value of proteins for maintenance. *J. Dairy Res.*, **6**, 289-302, 1935.
2. Blackwood, J. H., and Wishart, G. M.: The effect of salivary activity on the composition of bovine blood. *J. Physiol.*, **86**, 37-45, 1936.

3. Blackwood, J. H.: A technique for the determination of lactose in milk by the Hagedorn-Jensen method. *J. Dairy Res.*, **5**, 245-249, 1934.
4. Jordan, L.: The eradication of bovine tuberculosis. *Sp. Rep. Ser. Med. Res. Counc. Lond.*, No. 184, 1933.
5. Scott, A. W., and Wright, N. C.: An inquiry into the design, operation and efficiency of pasteurising plants. *Hannah Dairy Res. Inst. Bull,* No. 6, 1935.

39. DAIRY BACTERIOLOGY DIVISION, MINISTRY OF AGRICULTURE FOR NORTHERN IRELAND

The work of the Division has been mainly confined to problems and routine work in connection with the administration of the Milk and Milk Products Act (Northern Ireland), 1934.

During the year under review investigations were continued with a view to laying down bacteriological standards for graded milk. Standards have now been adopted as a result of this work (1).

Investigations were continued on the problem of improving the water supplies on farms and at creameries. Routine work was also carried out on the control of butter and cream production at creameries.

Title of paper issued during the year.

1. Statutory Rules and Orders of Northern Ireland, Nos. 69, 70 and 71, 1934. *H.M. Staty. Office.*

I

AGRICULTURAL ECONOMICS

40. AGRICULTURAL ECONOMICS RESEARCH INSTITUTE, OXFORD UNIVERSITY

Unemployment and land settlement.—Land settlement problems have been under consideration as a possible contribution towards the alleviation of unemployment. The history of land settlement during the past hundred years, for the purposes of poor relief and for the provision of an agricultural ladder, has been studied, and a special investigation was made of the experience of the County Councils and of their tenants in a group of Midland counties under the various Land Settlement Acts since 1908. The results are unfavourable to any scheme for the rapid extension of the subdivision of land for the settlement of the unemployed, either on subsistence or on commercial smallholdings (3).

The sugar beet industry.—Since the passing of the Beet Sugar Subsidy Act, 1925, the Institute has been engaged upon a continuous study of the economics of this new industry. This work was summarised during 1935 (4). The general inference is that the continuance of State aid to the home-grown sugar industry must be based upon political rather than economic arguments.

The regulation of food imports.—One of the objects of the new State control of agriculture has been the quantitative regulation of food imports in the interests, first, of the home producer, and second, of the Empire producer. The first effects of the steps taken have been studied (5). It is shown that there has been a marked reduction in total imports since 1931, notwithstanding a sharp rise in the import of Empire products.

Progress in farm management.—The eighth study of special examples of successful farm management involving some new principle or practice dealt with a business in the West Midlands upon which market gardening on a large scale has been developed by the application of machinery, much of it designed by the growers themselves. The farm is also an example of specialisation in production, other parts of it being independently organised for continuous corn growing and for milk production by the milking bail system (6).

The regulation of milk prices.—The milk situation is a peculiar one, for whereas this country enjoys a virtual monopoly of the market for liquid milk, that for milk products, principally butter and cheese, is subject to competition from many countries both Empire and foreign. For some time past a study has been in progress of supplies and prices of milk and milk products, beginning with the pre-war period and continuing through war-time control, the attempts by producers and distributors to organise voluntary price agreements after the war, and concluding with the organisation and operations of the Milk Marketing Board following the virtual breakdown of voluntary agreements.

Problems in the mechanisation of farm operations. (a) *The harvester-thresher.*—The introduction of the harvester-thresher as a means to reduce corn growing costs has brought a demand for information on the replanning of cropping and of labour organisation which it entails, and information has been wanted, also, on the cost of the new capital equipment and the technical problems arising in its use. In 1934 and 1935, facts both statistical and financial were collected from every known user of the harvester-thresher, together with statements of general experience with it. While it is impossible to generalise from two seasons' work, much information is now available upon the economics of the new machinery.

(b) *The tractor.*—Another study completed during the year bearing on the extension of the use of mechanical power for farm operations, is one upon tractor costs, based upon daily records of work done, and the costs of manual labour, fuel, repairs and depreciation.

The cost of clean milk production.—It is well known that the Ministry of Health recognises various standards of quality in milk for liquid consumption. There has never been any great demand for milk of the highest quality, probably owing to its cost, and if the general standard is to be raised the question of cost will be important. An investigation was organised, amongst producers of " category " milk, to examine the question. Nearly 200 have been visited, representing more than one third of the total number registered by the Ministry of Health.

Miscellaneous.—A continuous study of farming costs and problems of agricultural production and marketing forms part of the regular routine of the Institute (9 to 27).

Titles of papers issued during the year.

(a) *BOOKS.*

1. The Agricultural Register, 1934-5. *Oxford Agric. Econ. Inst.*
2. Miscellaneous papers in agricultural economics. **7,** 1932-4. *Ibid.*
3. Orwin, C. S., and Darke, W. F.: Back to the land. *P. S. King & Son, London.*
4. Bridges, A., and Dixey, R. N.: British sugar beet. Ten years' progress under the subsidy. *Oxford Agric. Econ. Inst.,* 1934.

5. Murray, K. A. H., and Cohen, R. L.: The planning of Britain's food imports. A quantitative study of the effects of recent legislation. *Ibid.*

(b) *PAMPHLETS.*

6. Orwin, C. S.: Progress in English farming systems, VIII. Pioneers in power farming. *Ibid.*
7. Twenty-Second Annual Report and List of Publications. *Ibid.*

(c) *ARTICLES AND ADDRESSES.*

8. Orwin, C. S.: Farm economics. *The farmer's guide to agricultural research in* 1933. *J. R.A.S.E.*, **95**, 242-258, 1934.
9. ————: The agricultural policy in action. *Ibid.*, **95**, 9-17, 1934.
10. ————: La legislazione sociale e il lavoratore agricolo in Inghilterra. *L'assistenza sociale agricola,* **7**, 337-343, September, 1934.
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(d) *PERIODICAL.*

28. The Farm Economist. **1**; 8, 9, 10 and 11.

41. FARM ECONOMICS BRANCH, DEPARTMENT OF AGRICULTURE FOR SCOTLAND

Investigation of the profitableness of farming.—The number of farm accounts so far received through the Agricultural Economists at the three Agricultural Colleges for use in the preparation of the annual Reports on the profitableness of farming has steadily increased from 50 in 1927-8 to 260 in 1933-4. The compilation of the 1932-3 report was completed during the year (1), and the 1933-4 figures were examined.

Up to the present this enquiry has only dealt with the study of farm accounts but with the steady growth in the number of accounts handled more and more types of farming are receiving representation. Steps are now being taken, in collaboration with the Agricultural Economists, to widen the scope of the enquiry still more by obtaining an adequate sample of accounts from various types of small holdings. The co-operation of a number of small holders in Aberdeenshire has already been received.

The analysis of the Agricultural Statistics and the classification of farms by type has been resumed. This is to form eventually the basis for the selection of farms to provide accounting data, and should also permit of fairly accurate generalisation being made from a small body of accounting data for the Agriculture of a wide area or even of the whole country.

Enquiry into the cost of milk production.—Reference is made to the previous report. The accounting year for the purpose of this special enquiry closed about November 1935. Statements dealing with an analysis of the records obtained in each Milk Board area will be available shortly.

In the late summer of 1935 the Milk Boards agreed to finance the enquiry for a further year.

Economic survey of small holdings.—Following on the completion of this enquiry, referred to in the 1933-4 report, a report was published (2).

Other enquiries.—An important aspect of the work of the Branch involves the consideration of the economic implications of new developments in Scottish agriculture and in agricultural policy. During the year particular attention has been devoted to matters concerning cattle and beef, sheep and mutton, pigs and bacon, and small holdings.

General.—Arrangements have been made to keep accounting records for 20 unemployed plotholders who have been placed on new type small holdings at Stonebyres, Lanarkshire.

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PRESERVATION AND TRANSPORT

42. DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

FOOD INVESTIGATION*

Fruit and Vegetables.

The trials of storage with control of oxygen and carbon dioxide, humidity and temperature at the Ditton Laboratory have been concerned during the year with English pears. Three varieties have been studied during two seasons—Comice, Conference and Williams; the trials with pears will probably continue for another two years.

The results on cold storage without control of the atmosphere emphasised the importance of removing the pears from store before they passed a critical stage after which they would not ripen properly, and also the importance of the temperature for conditioning or ripening the fruit after removal from cold storage (5). In the experiments with Conference and Williams pears, the atmosphere was controlled as well as the temperature, and the results show clearly that control of the atmosphere is an efficient method for obtaining a considerably longer storage-life than is possible with control of the temperature alone.

Investigations of the ascorbic acid (vitamin C) of apples have continued, with the interesting discovery that in young apples the greater part, if not all, of the vitamin is present in the reversibly oxidised form, i.e., its vitamin properties are intact although its presence is not indicated directly by the indophenol test.

Work has been done on the cold storage and gas-storage of potatoes, carrots and asparagus. Good preservation of asparagus for three weeks at 1° C. (34° F.) has been obtained. Work on the gas-storage of potatoes has confirmed previous observations (21) that carbon dioxide markedly affects the starch-sugar ratio. Carbon dioxide retards the setting of the skin of new potatoes, but more work is required before the best conditions for the storage of potatoes can be defined.

Meat, Fish and Eggs.

Research on meat, fish and eggs continues to develop along two main lines; their structure and chemical composition, and the conditions of handling and storage necessary to prevent undesirable change.

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* A full account of the work will be found in the Report of the Food Investigation Board for the year 1935. (H.M. Stationery Office.)

Improved methods have been worked out for the estimation of each of the individual proteins of meat. After death, the protein collagen is gradually broken down to gelatin with a consequent improvement in the tenderness of the meat; measurements have been made of the rate at which this reaction proceeds.

Rancidity in fats, particularly that due to oxidation, has been shown to be independent of the acidity of the fat, but it is particularly susceptible to the presence of traces of heavy metals, e.g. copper and iron. Work has been continued on the nature of the natural antioxidants in fats, and the possibilities of treating fats with substances of an antioxidative character in order to delay the onset of rancidity.

A study has been made of the rates at which bacteria are killed when exposed to α, β and γ rays. Apart from its direct interest, this work is a contribution to the general problem of the mechanism of bacterial sterilisation.

Other investigations include (a) the evaporation of water from meat, (b) the oxidation of haemoglobin by oxygen, the change largely responsible for loss of bloom, (c) denaturation of the protein myosin, affecting the texture of meat, (d) the action of ozone on fats and bacteria, and (e) the death of bacteria when exposed to freezing temperatures.

For the storage of fish beyond a few days, the most satisfactory method is by some form of rapid freezing followed by storage at low temperatures. Recent work has shown that with both white and fatty fish, storage at −28° C. gives a better product than storage at—20° C. The superiority of the lower temperature is shown by the better appearance of the fish when thawed, when cured and, in the case of fatty fish, by the absence of rancidity. The best temperature of storage will depend upon the storage period, but in the case of the herring, for example, which is caught over a period of about six months, a temperature of −28° C. would appear to be essential if the fish is to be stored for the remaining six months of the year.

Experiments on haddocks have shown that the normal stiffening of rigor can be delayed for as long as four months if the fish are frozen soon after catching. The sea-weedy flavour of fresh lemon soles can be preserved for the same period by storage at −28° C. Both are excellent examples of the value of freezing in preventing even the most subtle chemical changes.

A start has been made on the estimation of the individual amino acids in the proteins of the muscle of the cod, and so far 55 per cent. of the total nitrogen has been accounted for. This work is being extended to the individual proteins of meat and fish, not only because of its importance in nutrition, but also because of the light it may be expected to throw on the physical chemistry of the proteins.

The study of the metabolism of fat in fish has been advanced by an analysis of the changes in the fat of the salmon's egg during development up to the time of spawning. The general problem of fatty metabolism is one of great complexity, but the picture is now sufficiently clear to warrant experiments on the controlled feeding of living fish.

Other researches in progress include (a) the estimation of the individual proteins in fish muscle, (b) the 'light curing' of herrings, (c) the fatty acid and glyceride structure of herring oil, (d) rancidity in fatty fish, and (e) the identification of the anaerobic bacteria in the slime and intestines of fish.

Research on eggs has consisted mainly in a study of the protein mucin and the protein-lipoid complex lecithin-vitellin; the former controls the properties of the white and the yolk-membrane, the latter the appearance and consistency of the yolk.

During storage there is a general weakening and liquefaction of the egg, whilst it may also be attacked by mould. Experiments are being carried out to see how far these two types of change can be minimised by means of storage in air containing different concentrations of carbon dioxide, oxygen and nitrogen. Sufficient data have now been obtained to justify the extension of the work on a larger scale.

Pig products.

A scientific study of quality in pork and bacon is in progress. It has been found that the changes which occur in the various tissues of the pig during growth are reflected in the quality of both pork and bacon. The proportion of fat in the fatty tissues increases with age, and the fat becomes more saturated (i.e. harder). The proportion of fat in the muscles (lean meat) also increases, except immediately after weaning, when the growth of the muscular tissue temporarily outstrips the rate at which the fat is being deposited. The proportion of fat in the tissues is also affected by the position of the tissue in the body. Thus, there is considerably more fat in the muscular tissue near the shoulder than in that of the loin.

An experiment carried out with pigs supplied by Cambridge University Farm showed that restriction of the pig's diet led to a slowing down of growth. This affected the fat to a greater extent than the lean, but the fatty tissues were not all affected to the same extent, the back fat over the shoulder being affected more than that over the loin.

An important criterion of quality in bacon is the thickness of the flank. It has now been shown that this can be increased by fasting the pig immediately before slaughter.

The state of the pig when slaughtered has a far-reaching effect on the muscular tissues (lean meat) of the carcase. A measure of this effect has been obtained by determinations of the electrical resistance. Carcases from pigs killed in an overheated state tend to have a higher electrical resistance than normal and the meat from such carcases behaves less satisfactorily during dry-salting.

Canning.

The new frozen pea industry has now been placed on a sounder technical footing through the elimination in the laboratory of the chief causes of spoilage. Of these, yellowing and off-flavour are (*a*) bacterial and (*b*) cultural and varietal in origin. Type (*a*) is prevented by prompt cooling after blanching; type (*b*), and also the tendency of the skins to toughen and wrinkle, is prevented by adding 0·1 to 0·2 per cent. of sodium carbonate to the blanching and covering waters.

Fruits stored at —10° C. for jam usually lose some pectin, but vary in this respect according to condition and variety. Fruits preserved with sulphurous acid fall into two classes, viz., those in which the pectin is and is not destroyed. Sulphurous acid usually toughens the skins and other tissues; this, together with the destruction of pectin, is prevented by heating and then cooling before adding the preservative. Under these conditions the setting value of the pectin usually becomes considerably augmented.

Data of interest to the canning industry on the cool storage of soft fruits have been obtained, and a trial has shown the superiority of spray-lacquered cans to ordinary twice-lacquered cans for coloured fruits.

Titles of papers issued during the year.

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43. FRUIT AND VEGETABLE PRESERVATION RESEARCH STATION, CAMPDEN, BRISTOL UNIVERSITY

Chemical Investigations.

Gases in canned fruits and vegetables.—A method has been evolved of extracting and analysing the gases contained in the inter-cellular spaces of fruits, and a series of tables have been drawn up showing the alteration in the composition of the gases in the headspaces of cans during the early period of storage (9). The work has now been extended to include analyses of the headspace gases during the period when hydrogen develops in appreciable quantities.

The composition of the gases present in the inter-cellular spaces of vegetable tissues has been studied, and analyses of the headspace gases in canned vegetables are being carried out.

Diffusion of acid and sugars during the processing and storage of canned fruits.—The changes in pH and acidity which occur during the canning process are important in so far as the question of sterilisation is concerned, and subsequent changes in the acidity and the density of the syrup are of interest in connexion with the examination of newly packed cans.

Investigations into this subject have shown (2) that after completion of the diffusion of the sugar little chemical change takes place apart from inversion of the sugar and slight corrosion of the container.

During the year under review, the chemical changes taking place in fruits during ripening have been studied, and the values obtained will be correlated with the quality of the product resulting from canning the fruit at various stages of ripeness.

Texture of canned fruits and vegetables.—An apparatus was devised for measuring the toughness of fruits and vegetables. Hard water used in preparing the syrup or brine does not appreciably toughen the skins of fruits or of most fresh vegetables, but the toughness of skins of fruits increases with the strength of the sugar syrup used (8).

Tin in canned vegetables.—During the past two years over 1,000 samples of fruits have been analysed for the presence of tin, and the effect of lacquer protection, time and temperature of storage, and type of fruit have been studied.

A similar investigation on the tin content of canned vegetables is being carried out.

Loss of mineral salts during canning.—A preliminary investigation of this subject was undertaken during the past season. Peas, stringless beans and carrots were analysed for calcium, magnesium, potassium and phosphorus. The raw material before and after blanching, and the final canned products, were examined in this way, and compared with corresponding samples which had been cooked in the usual domestic manner. The results were sufficiently interesting to encourage a more complete study of the subject during 1936.

Extraction of solids in canned fruits.—The effect of length of time of sterilising on the soluble solids found in the syrup has been studied. Breakdown of acid-hydrolysable substances may have an appreciable effect on the final density of syrup.

BIO-CHEMICAL INVESTIGATIONS.

Ripening of peas.—This is the fourth season in which these tests have been in hand, and the results obtained add considerably to our knowledge of the changes taking place during ripening of green peas. The analyses of the previous year's crop were completed in April 1935, and all five wrinkled-seeded varieties tested showed that, while the chemical composition of the peas was not closely related to the size or to the stage of early maturity, a marked change took place at a period of two to four days after the normal " canning stage ". This change occurred in peas of all sizes, and consisted of a rapid fall in sugars, and a rise in starch, insoluble solids and total solids. The chemical composition of the round-seeded variety Alaska varied greatly with the size of the peas, and the maturity of the crop. The tests made in 1935—the peas from which are now awaiting analysis—have been designed to cover a wider range of maturity and to extend almost to the harvested seed stage.

Composition of harvested peas.—The work on this subject has been continued in an endeavour to ascertain whether the texture of dried peas is influenced by the period elapsing between harvesting and threshing, or by the type of land on which the peas are grown. English Small Blue peas were obtained from about 20 sources where the conditions of cultivation and type of soil were known, and these were threshed out as required. Canning trials were carried out together with absorption tests, and analyses were made for sugar, starch, insoluble solids and calcium content. No definite relationship between any of these factors and the texture could be established. Subsequent tests on samples of hard and soft peas tended to indicate that the phosphorus content exerted an influence on the texture.

Manurial trials have been carried out during the 1935 season under the guidance of the Midland Agricultural College, and the effect of potash, nitrogen and phosphorus, both singly and combined, is being studied.

BACTERIOLOGICAL INVESTIGATION.

Thermophilic spoilage.—The study of thermophilic bacteria causing " flat sours " in vegetables has been continued. Six samples of American, two of French and sixteen of English sugars have been tested, and sixteen cultures of thermophilic bacteria have been isolated. These have been described, and thermal death point determinations have been carried out. In addition, samples of " blancher " water from eight factories have been examined, and the thermophilic bacteria isolated are being compared with those isolated from sugar.

Byssochlamys fulva.—The experiments on this fungus have been continued. Tests were made to ascertain the amount of infection on fresh fruit as received at the Research Station for canning. The results for gooseberries, strawberries, loganberries and yellow plums indicate a reduction in the amount of natural infection during this as compared with the 1934 season. Canning experiments to determine the necessary time and temperature for the destruction of the natural infection on the fruit were carried out.

PHYSICAL INVESTIGATIONS.

Vacuum in Cans.—Methods of measuring the vacuum inside cans without puncturing the tinplate have been studied (3). The depression of the ends was measured by a spherometer, and a relationship between the extent of the depression and the internal vacuum was established. The alteration in volume brought about by the internal vacuum was also studied. A new method of measuring vacuum has been devised by means of reducing the external pressure until the ends of the cans dome.

Heat Penetration.—Thermocouples have been used for measuring the rate of heat penetration in cans which are enclosed for the purpose in a special stationary retort. For determining the rate of heat penetration in automatic retorts, small maximum thermometers fixed diagonally in the cans have been used. A series of curves have been obtained for vegetables processed in the various sizes of cans at 240° F., 250° F., and 260° F.

CANNING AND BOTTLING EXPERIMENTS.

The short crop of all fruits reduced the extent of the canning trials carried out during the summer months, but the tests made during the rest of the year were fully up to the usual number.

Hydrogen Swells.—Encouraging results have been obtained from cans in which special precautions had been taken to protect the seams from the action of the fruit acids. Further tests have been carried out on cans prepared from a special type of tinplate.

Variety Trials.—The 1935 season was an unfortunate one for obtaining samples of fruit, no varieties being sent from Wisley. Several new varieties of fruits and vegetables were, however, obtained from other sources.

Evaporated Milk.—A new small evaporator was constructed for use in conjunction with tests on the canning of evaporated milk, and experimental work on this subject has been carried out.

Effect of Temperature.—The effect of temperature on the drained weights of bottled fruits has been studied, particularly in regard to the use of rapid high temperature processes.

Discoloration from Caps.—Methods of preventing discoloration in bottled fruits due to contact of the fruit with the metal caps have been investigated.

Titles of papers issued during the year.

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AGRICULTURAL ENGINEERING

44. AGRICULTURAL ENGINEERING RESEARCH INSTITUTE, OXFORD UNIVERSITY

Tractors and tractor dynamics.—The earlier work on tractor wheels consisted of tests over a wide range of load in which both the input to the tractor wheels and the useful output were measured. The difference between these quantities, i.e. the total wheel loss, was separated on a partly conventional basis into loss by rolling resistance and loss by slip. The later work has aimed at exploring the factors on which the rolling resistance loss depends. All tests so far carried out suggest that this loss is independent of the amount of wheel slip and of the speed of test at any rate over the rather limited range of speeds available in most tractors. Independence of the amount of slip should in theory make the work easier by rendering tests under load unnecessary. Unfortunately, however, the ground available at the new Field Station has proved in practice to be so variable that the results of single no-load tests are unreliable unless supported by observations under load which in the circumstances are difficult to carry out.

Independence of speed, on the other hand, has provided a starting place for a semi-mathematical investigation on rolling resistance, since it leads to the conclusion that the soil factors which affect the problem are of the nature of stresses only. The particular stress-factor concerned appears to be the pressure between the soil and those parts of the wheel which penetrate it. Further work on these lines with actual tractor wheels has had to be deferred since uniform soil is essential to success. A mathematical expression applicable to plain rigid wheels has been worked out and has been fairly well verified by experiment; the necessary soil stress factor being estimated both by penetration experiments and by measurement of the depth of the wheel ruts.

Dynamometers: new type of construction.—The earlier indicating and recording instruments depended on the measurement of the extension of a coiled spring. The mounting of this involved a somewhat expensive mounting for each spring, and there was in some cases difficulty in obtaining a definite end point under maximum extension. The new design uses a coiled spring in compression, which gives a sharper end point and obviates the need for a special mounting for each. At the same time, the number of ranges for each instrument has been increased.

Implements.—Grassland cultivation. In view of the growing interest in grassland improvement, special attention is being given to the question of implements for regenerating grassland.

In addition to the work on Thames Valley type meadow, experiments have been carried out at several other centres, such as Cilmery Park, near Builth.

Although in the majority of cases there are strong arguments in favour of ploughing and resowing derelict grassland, this is not always economically practicable. The experiments of the Institute have, in particular, been devoted to the removal of " mat " by mechanical means and the making of a partial seed-bed in existing turf for the introduction of clover and other seeds, either by " ripping "—i.e. the creation of continuous exposed lines of soil, or " divoting ", the production of more or less irregularly spaced pockets of bare soil.

In general it would appear that two distinct methods of treatment are indicated, depending on whether the land treated is in a high or low rainfall area.

Work has been done with a wide variety of implements, both at high and normal speeds, and as a tentative generalisation it would appear that in a given area equal results will be produced when the input of horse-power-hours per acre is the same. From the purely practical viewpoint, as the result of this, the most useful machine is that which requires the least amount of time for cleaning: the amount of material removed in the process of grassland regeneration being several tons per acre.

Haymaking.—The Institute's work on haymaking is the corollary to that done by other bodies on the preservation of grass by artificial drying or ensilage, and is aimed at preserving the proteids and carotinoids of ripe grass as far as possible, with the reduction of losses in these during the " making " in the field. The present line of research in the production of high moisture content baled hay is the direct outcome of work started some years ago with the " Combine Baler ". The original function of this machine appears to have been to reduce the loss of leaf lamina in the collecting of lucerne and other broad leaved hay, and trials with this object in Hampshire proved remarkably effective. It was found in the same season that it was possible to make baled hay in the field with a very much higher moisture content than was normally considered sound practice and to keep this in the stack without loss or deterioration, and in successive seasons (using the machine as a stationary baler, which permits a higher rate of working) the safe percentage has been raised until it is now possible to make good hay with an initial moisture content of 25-28 per cent. as against 16-18 per cent. for normal practice. Hay made in this way is greener in colour and more appetising than the normal product, and keeps excellently. It is not comparable with dried young grass, since a certain amount of fermentation takes place in the stack, giving the characteristic " fruity " odour of perfectly ripened hay, but the method would appear to be the most practicable method of preserving a ripe crop of grass so far devised.

It may be noted that the hydrometric method of moisture content measurement originally devised by the Institute for use with grain on farms has proved unexpectedly useful for work on hay, and particularly with herbage where the content may be as high as 90 per cent. and has both shortened and simplified the measurement of these in the laboratory.

The normal development of this work on high moisture content hay will be in the investigation of other methods and machines for attaining the same result, particular attention being given to the new German balers which produce a loosely tied truss instead of a highly compressed bale. The actual process of cutting and making hay in the field, which has received little attention in recent years, is also under investigation, as it is evident that, even under perfect conditions, avoidable losses of proteid, carbohydrate, and carotinoid are taking place.

Market garden tractors.—There is a widespread demand for machines capable of working under heavier conditions, particularly for use in row crops. It does not appear satisfactory to attach the tines to the rear of the machine for close work in the rows, unless a special steering linkage is provided, as in one imported machine, and if the tines are attached in front a stronger framework must be fitted and means provided to take up the altered reaction. Even with a strengthened frame it is almost essential for each tine to be independently mounted and spring loaded to deal with irregularities and unevenness of the terrain.

Field spraying.—A number of experiments were made to ascertain if the efficacy of spraying with sulphuric acid could be increased by attaching to the sprayer some form of device which would spread out the droplets of the spray into a continuous film on the leaf, the mechanical equivalent of using a chemical " spreader ". These gave results tending to show that the efficacy of spraying is lessened by increasing the surface of the droplet.

The development of field spraying for weed control has now apparently reached a satisfactory stage, both as regards the provision of satisfactory commercial equipment and its use, and the costing of the operation.

Grain storage.—In view of the growing importance of grain storage on the farm, both from the viewpoint of improving the marketing of cereals, of reducing the losses incurred in rick storage, and also with the object of obtaining more efficient grading and cleaning of grain, the Institute is now devoting considerable attention to the subject of bin storage on farms. This has long been normal practice in other countries of the Empire, notably Canada, and has now become a practical possibility in this country owing to the rapid spread of methods of harvesting in the field, whether with binders and threshing boxes or with combine harvesters, the significant factor in each instance being the availability of grain drying equipment.

Steps are being taken to explore the possibility of co-operative grain storage and cleaning plant.

Electricity in agriculture.—The policy of the Institute in connection with this subject is to make available to the agricultural community existing applications rather than to carry out research on new uses of electricity.

A study of farm wiring showed that one of the most important points in this field was the necessity of providing adequate protection against shock to human and animal life from leakage potentials. This is a particularly difficult question on the majority of farms where the normal methods of protection are ineffective. Two main lines of investigation are being followed:—

(i) The determination of the importance of the problem: arrangements have been made to carry out next year (1935-6) regular monthly tests of the earthing resistance on a number of farms representing different sub-soil conditions. When the period of worst earthing condition is reached (probably in late Autumn) a large number of farms will be tested to determine the proportionate importance of the problem.

(ii) The development of satisfactory protective appliances: tests under laboratory and farm conditions will be made of different makes of leakage trips.

A rapid national survey was made of the applications of electricity to poultry farming and their relative technical and economic merits. The general conclusions were that there were sound electrical methods of applying any required heat, light and power, but that it required a careful estimation of the probable running costs to determine just how far one could go. In certain cases where low tariffs were available all applications could be run electrically: this is particularly true on small farms, since the larger establishments could reap the benefit of the low-running costs of centrally heated plant.

Titles of papers issued during the year.

(a) *PERIODICALS.*

1. *Farm and Machine,* **2,** 96, 1935.
2. Abstracts of Current Literature, Nos. 13 to 16, October, 1934, to July, 1935.

(b) *PAMPHLETS.*

3. Brown, C. A. C.: Farm wiring, February, 1935.
4. ———: Electricity in poultry farming, August, 1935.

(c) *ARTICLES AND PAPERS.*

5. Black, E. B.: Tractor data sheet. *Farm and Machine*, **2**, 96, 1935.
6. Brown, C. A. C.: Farm electricity tariffs. *Ibid.*, **2**, 45-54, 1935.
7. ———: Farm water supply equipment. *J. Min. Agric.*, 319-325, July, 1935.
8. Cashmore, W. H.: Market garden tractors. *Farm and Machine*, **2**, 38-44, 1935.
9. Dawson, S. H. W.: Some notes on the operation and maintenance of diesel engines on the farm. *Ibid.*, **2**, 33-38, 1935.
10. Denham, H. J.: Grain-cleaning equipment for farms. *Ibid.*, **2**, 67-73, 1935.
11. ———: Implements for regenerating grassland. *Ibid.*, **2**, 90-95, 1935.
12. ———: Review of the progress of electrification in modern English farming practice. *J. Min. Agric.*, 221-230, June, 1935.
13. ———: Some trends in mechanized farming. I. The grain harvest. *Scott. J. Agric.*, 361-366, Oct., 1934.
14. ———: Some trends in mechanized farming. II. Grass. *Ibid.*, 14-19, January, 1935.
15. MacDowall, R. K.: Potato blight: a new method of control of chemical spraying. *Ibid.*, 243-249, July, 1935.
16. ———: Progress in arable spraying machinery and methods during 1934. *Farm and Machine*, **2**, 54-61, 1935.
17. Newman, J. E.: Sugar-beet harvesting. *Ibid.*, **2**, 79-90, 1935.
18. Wilson, J. S.: The Institute traction dynamometer. *Ibid.*, **2**, 27-33, 1935.
19. Wright, S. J.: Some features of modern tractor design. *J. Inst. Automobile Engineers*, 195-224, December, 1934.
20. ———: Machinery in vegetable production. *Sci. Hort.*, **3**, 97-108, 1935.
21. ———: Tractor facts and fancies. *Farm and Machine*, **2**, 23-27, 1935.
22. ———: Farm implements and machinery. *J. R.A.S.E.*, **95**, 218-241, 1934.

II LOCAL INVESTIGATIONS AT ADVISORY CENTRES

CHEMISTRY

45. ABERYSTWYTH: UNIVERSITY COLLEGE OF WALES

Silage investigations.—Different crops have been ensiled in successive years at the College Farm, several methods being used each year. The following is the percentage loss of dry matter by different methods: Molasses 9·3, Defu 9·5, A.I.V. 15·5, Ordinary 28·0. The order of palatability to cattle is Molasses; Ordinary; Defu and A.I.V.

Oats.—Samples of grain and straw of 14 varieties, including new varieties produced by the Welsh Plant Breeding Station and others commonly grown, were obtained from trial centres throughout the Province and chemically examined. Both as regards grain and straw, the new varieties were superior in yield and in quality. The grain of all varieties showed little variation in composition between upland and lowland grown plants, but the straw of any one variety was richer in protein and ash when grown in the uplands.

Pasture weeds.—Work on the composition of pasture weeds consumed by stock has been continued, and extended to include weeds found in seeded or unseeded stubbles. It has been shown that many "weeds" are at certain seasons of the year a valuable constituent of pasture.

Action of clover on grasses.—Work is in progress on the influence that clover grown with grasses has on the composition of the latter. Plots of rye grass and of cocksfoot, with and without clover, have been laid out: monthly samples are being taken for chemical analysis, and the plots grazed with sheep, whose live-weight increase is recorded. The experiment is designed to run for three years, and the first year gives promise of results of considerable interest and value.

46. BANGOR: UNIVERSITY COLLEGE OF NORTH WALES

Soil survey.—The area surveyed during the present season was in N. Cardiganshire, and included the upland area of the Cahn Hill Improvement Scheme. It is an area of relatively simple geology, in which the soil variations are mainly connected with superficial geology and drainage conditions. It is hoped to link up the results of the soil investigation with the experience gained in the hill improvement scheme.

In addition to the ordinary soil survey, an investigation of certain estuarine sandy areas was made. Four areas have been surveyed in detail, and the data obtained will serve as fundamental information for possible schemes for the better utilization of these areas. There appear to be distinct possibilities for horticultural development.

General investigations.—Investigations on the rate of loss of lime by leaching from N. Welsh soils have been concluded. The average rate of loss, with an annual rainfall of about 40 ins., is about 100 lb. CaO per annum. With higher lime status, the rate of loss is increased. It would appear that, with soils of satisfactory lime status, dressings supplying about 150 lb. CaO per annum should be sufficient. This would mean about 1 ton per acre of ground limestone in each rotation.

The phosphorus compounds of soils have been investigated. The results hitherto obtained show that, with acid soils, comparatively little of the soil phosphorus can be present as compounds of the apatite class. It is intended to study the reaction of soils with phosphatic dressings in the hope of gaining some insight into the causes of reversion.

Investigations of certain feeding stuffs grown in N. Wales and of mountain soils have been continued.

Titles of papers issued during the year.

1. Hughes, D. O., and Walters, W. G. D.: Soil survey of Wales. Progress report, 1931-34. *Welsh J. Agric.*, **11**, 188, 1935.
2. Robinson, G. W.: Soil surveys and their applications. *J. Min. Agric.*, **42**, 561, 1935.
3. Robinson, G. W., and Wasowicz, T.: Preliminary studies on N. Welsh mountain soils. *Proc. 3rd Int. Congr. Soil Sci.*, **1**, 310, 1935.
4. Robinson, G. W.: Soils of Great Britain. *Ibid.*, **2**, 1935.

47. BRISTOL UNIVERSITY

In addition to the investigational work outlined in the previous report, the following investigations have been commenced:—

(a) *Nitrogen and mineral uptake.*—A series of experiments was commenced at the end of 1934 with the purpose of investigating the effect of various fertilisers, both singly and in combination, upon the uptake of nitrogen and mineral constituents of grasses and clovers.

(b) *Poultry grassland.*—A study of the effect of poultry on the composition of grassland herbage is in progress and for this investigation samples of herbage from County Egg Laying Trial Centres are being examined.

(c) *Swede experiments.*—Varieties of swedes grown on different soil types in Somerset have been examined and the data obtained have enabled the Adviser in Agricultural Economics to compare the value of feeding stuffs grown in the Province with that of similar feeding stuffs grown elsewhere.

(d) *Sprouted maize and barley.*—Samples of sprouted maize and barley have been examined in connection with this method of obtaining succulent fodder. The results indicate that the process causes a loss of digestible carbohydrate and an increase in fibre content.

(e) *Poisoning of poultry on the Mendip Hills.*—Samples of viscera of chickens, ducks and geese, kept on the Mendip lead mine district of Somerset were examined. Toxic amounts of lead were found in all samples, and lead was also found in the soils over which the birds had been allowed to range. Chronic lead poisoning prevailed among the flocks on the farms where the investigations were carried out.

(f) *The Bath and West Society's pig investigation.*—The field work in connection with this investigation which is being conducted in collaboration with the Agricultural Organiser for Wiltshire has been completed.

Titles of papers issued during the year.

1. Ling, A. W.: Report of the Third Grassland Conference, Switzerland, 1934. Bull. 13, *University of Bristol.*
2. Price, W. T., and Ling, A. W.: An investigation of pig husbandry in the South West of England (Interim Report). *J. Bath & West Soc.,* **9,** Sixth series, 49-55, 1934-35.
3. Ling, A. W.: Improvement in feeding value of Worcestershire pastures. *Worcs. Chron.,* **3,** No. 2, June, 1935.
4. ————: Improvement in feeding value of Herefordshire pastures. *Heref. J.,* **3,** No. 2, 1935.

48. CAMBRIDGE UNIVERSITY

Chicory (for drying).—The trials have been continued. Results indicate that no heavier dressings of fertiliser are required than for sugar beet, and there was no advantage in applying half the nitrogenous fertiliser at a later date. Spacing has a marked effect on yield, while soil acidity has about the same effect as on sugar beet.

Lime and phosphate trials.—These have been continued, with the addition of a further trial centre on land in rather better condition.

Application of fertilisers.

(i) Ploughing-in *versus* broadcasting on seed bed. The experiments have been continued with the addition of a further experiment dealing with phosphorus and potash fertilisers on sugar beet.

(ii) Drilling with seed *versus* broadcasting. This experiment with barley has been concluded. The results indicate that for this crop drilling of fertiliser with the seed is superior to broadcasting the fertiliser, provided the seed bed is moist.

(iii) Hand drill experiments have been carried out to determine the effect of individual fertilisers sown at various rates on barley and sugar-beet seed: also on the differences between sowing fertiliser and seed through separate coulters, and through the same. The relative position of seed and fertiliser seems to be important.

(iv) Laboratory studies are being made of the effect of the presence of fertiliser on the germination of seed.

Effect of rarer minerals.—Field tests confirmed the observations at other centres, that heart-rot of sugar beet can be controlled by the application of borax.

An experiment has been established to test the effect of magnesium, and any interaction it may have with potassium in light, dry soil.

Market garden crops.—Experiments on the manuring of these crops have been continued.

Titles of papers issued during the year.

1. Nicholson, H. H., and Hanley, F.: Soil conditions in East Anglia. *Emp. J. Exp. Agric.*, **3**, 60, 1935.
2. Hanley, F.: Notes on the feeding and manurial value of various by-products. *Husbandry*, **5**, 7, 42, 70, 1935.
3. ———: The agricultural education exhibit at the Royal Show, Ipswich. *Agric. Prog.*, 1935.
4. Rayns, F., and Hanley, F.: Notes on manuring. *J. Min. Agric.*, **41**, 1014, 1934.

49. HARPER ADAMS AGRICULTURAL COLLEGE

Soil survey.—Following the completion of a three year's programme the survey of a new area has been started and will ultimately complete the area covered by the O.S. Sheet No. 138. Several new series appear to be present and may ultimately be established.

Grey speck in oats.—This disease appears to be of fairly widespread occurrence and almost invariably associated with relatively recently enclosed common lands. It has again been the subject of experiment in Warwickshire. Some progress in its control has been made on a field scale by top-dressing affected crops with manganous sulphate.

Soil acidity.—The experiment, a 4 × 4 latin square with different amounts of lime, has been continued using potatoes. The noticeable differences present in the early stages tended to smooth out later in the season. Small progressive differences in yield were obtained with successive increases in quantity of lime applied.

Beet sugar factory waste lime.—In co-operation with the Bristol Province and the local beet sugar factories, an experiment designed to test the efficiency of waste lime in removing acidity has been laid down and completed. Both forms of lime (dry and wet sludge) were tested against standard ground limestone with satisfactory results in all cases.

Silage.—The experiment referred to in the previous report has been completed. The digestibility of the material was tested out by the co-operating firm.

Title of paper issued during the year.

1. Davies, W. Morley, and Owen, G.: A survey of the soils of North Shropshire. *Emp. J. Exp. Agric.*, **2**, 8, 13-33, 1934.

50. LEEDS UNIVERSITY

Investigational work.—Four demonstrations were carried out on the value of beet factory waste lime. The waste lime was compared in each case with ground lime and with ground chalk, applied at equivalent rates. Within the limits of experimental error, the waste lime was as effective as the other two forms.

One experiment on the value of common salt for sugar beet was conducted. All applications of salt (5, 7½ and 10 cwt. per acre) gave significant increases in yield of beet.

Several experiments on the use of weed killers were made, including the use of ammonium thiocyanate as a control for runch (*Raphanus raphanistrum*) in oats. At concentrations greater than 3 per cent. (100 gals. per acre) the thiocyanate was found to kill all the runch, but also caused a depression in the yield of oats. At concentrations less than 3 per cent. it did not prove a sufficiently effective control.

Sodium chlorate at the rate of ½ cwt. per acre, applied in solution, proved very effective as a control for tussocks (*Aira caespitosa*) on a pasture. The tufts were easily removed two months after treatment (February 1935), and the land was subsequently sown with wild white clover which germinated well.

Experiments were also carried out with two by-products of the gas industry, namely ammonium bicarbonate and crude ammoniacal liquor. The former was applied to a mustard crop, the latter to meadow hay and to potatoes. Both proved efficient nitrogenous fertilisers, with hardly any signs of toxicity.

Some horticultural crops like peas, broccoli and rhubarb were the subject of experiment.

Title of paper issued during the year.

1. Jones, H. Trefor: Soils of Yorkshire. *Emp. J. Exp. Agric.*, **3**, 11, 269-275, July, 1935.

51. MANCHESTER UNIVERSITY

Quality of hay.—The examination of hay stocks from farms in the area has been continued with particular reference to mineral content. The mean composition obtained from 16 samples showed very little difference in any constituent as compared with the 1934 crop, a result which was probably due to the comparative dryness of the two seasons. The most significant fact determined from these analyses is the low lime content in all samples associated however with the comparatively high phosphate and potash content. Results from samples obtained from limed and unlimed meadows showed a considerable increase in crude protein in the limed material and also an increase in all the ash constituents, the potash content in particular being very considerably increased.

Effect of lime and fertilisers on the mineral content of poor pastures.—The results obtained this year from four centres show the variable composition of the herbage grass on different soils and very low mineral contents on the most acid soils. On one very poor pasture lime applied in February of this year had increased the lime content of the grass by 500 per cent. by July. The effect of any dressing was reflected in the quantities of all the mineral constituents and changes were also produced in the crude protein.

Potash treatment for potato root eelworm disease.—Following the report of the success of heavy potash dressings as a control over this disease in Devon the treatment was tested at two highly infested centres in Lancashire. No response was obtained, however, from the application of 15 cwt. sulphate of potash per acre, but at both centres severe symptoms did not develop this year. It is probable that the soil factor associated with the development of this disease is not constant in different potato growing districts.

52. MIDLAND AGRICULTURAL COLLEGE

Molassed beet pulp (taint in milk) enquiry.—During the past year a study has been made of the changes which betaine undergoes during heating. The analytical methods for the determination of tertiary bases have been improved and estimations of the various tertiary bases occuring in a variety of samples of molassed beet pulp have been made.

The causes of low non-fatty solids in milk.—During the past 18 months periodic samples of milk from individual cows in a herd of pedigree Friesians have been taken and analysed and an endeavour is being made to correlate the percentage of non-fatty solids with the breeding history of the herd.

Grey speck in oats.—Series of experimental plots were laid down this year on a field known to produce this disease. Various manurial treatments have been tried out. This investigation is being continued in the coming year.

The manurial value of sewage sludge.—Plots were laid down this past season to compare the relative values of farmyard manure and sewage sludge on potatoes. Yields obtained indicated that the two were about equal in effect, and gave better results than artificials only or no manure. The residual value of these manures is being ascertained in subsequent crops.

Hardness in canned peas.—An investigation has been undertaken in conjunction with the Campden Fruit and Vegetable Preservation Station into the causes of hardness in processed peas. Numerous samples of Lincoln Small Blues from plots under varying manurial treatment have been harvested this year and are being subjected to analytical examination.

The effect of various manures on the quality of sports turf.—A study of the effect of various organic fertilisers on the quality of turf has been continued during the past season and promising results are being obtained.

The use of the chlorine test in milk as a means of detecting mastitis.—Several analytical methods advocated for the determination of chlorine in milk have been tried out and the results correlated with bacteriological examinations of milk from cows suspected of suffering from mastitis.

Chlorosis in fruit trees.—Several trees in advanced stages of chlorosis have been treated by the iron citrate injection method and the results are very promising. This work has been undertaken in collaboration with Long Ashton Research Station.

Titles of papers issued during the year.

1. Cranfield, H. T., Roebuck, A., and Stafford, J. G. W.: The control of mites in cheese stores. *Midland Agric. Coll.* Bull. No. 33.
2. Cranfield, H. T., and Mackintosh, J.: Taint in milk during the feeding of molassed beet pulp. *J. Min. Agric.*, **42**, 6, 551-560, 1935.

53. NEWCASTLE: ARMSTRONG COLLEGE, DURHAM UNIVERSITY

Composition of grass laid up for winter keep.—Two 3-acre plots at Cockle Park were laid up in August 1934: one was left unstocked through the winter, while the other was grazed from October-April. Samples were taken monthly from 17th October onwards from each plot. The amount of crude protein fell steadily to minima in December (ungrazed) and January (grazed). Protein digestibility fell to a minimum in January for both plots, rising thereafter. Crude fibre showed close negative correlation with crude protein: the values in replicate samples showed rather wide variations.

The ash content fell steadily through the winter, and the lime content followed it until February, when it rose sharply. The curves for grazed and ungrazed plots show certain differences. Phosphoric acid was very variable between replicate samples, but on the whole remained at a constant level.

Composition of stool bent or heath rush (Juncus squarrosus).—Analyses show that in early summer this compares favourably with recognised fodder plants. In winter its intrinsic value is less, but at that time it is a valuable constituent of poor *Nardus* pastures. It has no special value as a source of any particular constituent.

Feeding of alfalfa meal and dried grass.—Experiments have been made on the effect of the feeding of these on the colour of the milk of dairy cows. Ten pounds of dried grass per cow per day produced an increase in carotene content of 109 per cent., and 3½ lb. of dried alfalfa per cow per day produced an increase of 56 per cent.

Effect of intensive treatment on pasture grass.—A comparison of the yield and composition of pasture grass from intensively-treated and non-intensively treated plots at Cockle Park has shown that dry matter production has been increased by 20 per cent. owing to treatment, but that this has involved no change in composition except as regards total ash and the chief ash constituents. The non-intensive treatment gave a higher total ash content; phosphoric acid was higher under this treatment, and lime slightly higher.

Other investigations in progress.—These have included:

(*a*) Study of effect of draining on yield and quality of pasture grass.

(*b*) Continuation of the long term work on yield and composition of grass from Tree Field, Cockle Park: this has been extended on to the Hanging Leaves plots.

(*c*) Influence of nitrogenous manuring, rate and time of application, on the productivity of pastures. This work is being done in collaboration with a commercial research organisation.

(*d*) Manurial plots laid down on newly burned heather are making good progress.

(*e*) An investigation of the feeding value of heather indicated that it does not vary greatly throughout the year, but is highest in July and August.

Soil survey.—A soil survey has been made of Kyloe Woods, Northumberland.

Titles of papers issued during the year.

1. Thomas, B.: The significance of colour in milk. *The Jersey Cow,* **15,** 2, June, 1935.
2. ———: The composition and feeding value of some moorland plants. *Agric. Prog.,* **41,** 82-89, 1935.

54. READING UNIVERSITY

Solids-not-fat in milk.—Investigations into this problem are being continued along certain lines as circumstances permit. Two herds have been under close observation, and from one of them it has been possible to obtain much data of interest in connection with the effect of mastitis on the composition of milk. The data obtained so far would suggest that there is some relationship between milk with an abnormally low content of solids-not-fat and the after effects of mastitis.

Manuring of grassland.—In connection with the milk investigations experiments have been laid down with the object of improving the quality (and in particular the mineral content) of grassland herbage, and ascertaining whether it were possible in this way to influence the composition of the milk.

Soil survey.—An intensive survey of some 5,500 acres of Chalk land has been carried out in Hampshire. Eight series have been identified, and the results have proved of great practical value.

Chlorosis.—With chrysanthemums it has been found essential to treat with sulphate of iron when the calcium carbonate content of the soil is over 20 per cent. Carnations, although lime-loving in habit, suffer from chlorosis with excessive alkalinity: this takes the form of a loss of blue, not of green, colour from the foliage, with temporary fading and instability of flower colours. Iron sulphate is not as satisfactory a remedy as reducing the soil lime, by the use of acid turf, and incorporation of potash in the base manure.

55. SEALE-HAYNE AGRICULTURAL COLLEGE

Strawberry "patch" disease.—This work is being continued. Apart from the necessity of maintaining a high soil fertility, an important factor is the calcium level of the soil, for which there seems to be an optimum. The same is true of manganese, the effect of the two metals being probably related.

Effect of soil potash and phosphate level on tomatoes.—Observations carried out over three years on tomatoes grown in houses where the soil phosphate has been kept very low, and soil potash high, have shown that the yield under these conditions is consistently nearly 50 per cent. higher than normal; and although no soil sterilisation has been carried out, there has been no trouble with club-root or other diseases.

Winter browning of anemones in Cornwall.—This obscure trouble which attacks leaves, stems, and often roots in autumn and winter, is not due to fungal or insect attack; also it does not appear that weather conditions or salt spray are responsible. There is strong evidence that soil conditions, namely a fall in the amount of calcium and nitrogen present, are at least a predisposing cause. The trouble is practically restricted to plants grown from corms, those grown from seed being almost unaffected.

56. WYE, SOUTH-EASTERN AGRICULTURAL COLLEGE, LONDON UNIVERSITY

Lime-induced chlorosis.—The pear trees on which various remedial manurial treatments were applied in past years were observed. The trees in one-half of the orchard, where the drainage was improved two years ago, showed a marked improvement, while there was none in the other half, where drainage conditions were unchanged.

Spray materials.—A number of proprietary preparations for use against hop powdery mildew was tested during the year. It was found that the effect produced varied considerably with the spreader used.

Analyses have been made of samples of commercial hydrated lime, which is now being used in place of slaked burnt lime for Bordeaux mixture.

Mushroom investigations.—Work is being commenced on the chemical aspect of mushroom problems. Particular attention is to be paid to the relation of chemical composition to the changes in productivity, etc., of the compost.

Title of paper issued during the year.

1. Goodwin, W., Pizer, N. H., Salmon, E. S., and Ware, W. M.: The control of apple scab: Allington Pippin and Newton Wonder 1934. *J. S.E. Agric. Coll.*, No. 36, 55-61, 1935.

57. EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE

Special attention has been given to the development of rapid methods of routine examination. In this connection, 150 special samples from different parts of the world were analysed for a co-operative scheme of the International Society of Soil Science, designed to test the reliability of various simple laboratory tests in the estimation of fertiliser requirement. The method which has received most attention here is the *Aspergillus niger* method (1).

The special lawn investigation, in collaboration with the Advisory Botany Department, has been continued and 112 soil samples have been examined. Soil samples have also been taken from an area at Boghall, which has been placed under a manurial rotation experiment.

The investigation, which has been in progress for six years on the fluctuations in soil acidity, is still being continued.

The Department is collaborating in an intensive investigation on factors associated with " pine disease " of sheep in the Border counties and 72 soil samples from " pining " and " non-pining " areas are being analysed. In the meantime, attention is being directed more particularly to " available " iron and copper in the soils and similar analyses are being carried out on 83 samples of pasture, hay and sugar beet pulp from the same localities.

Reference has been made in earlier reports to the possibility of increasing the protein content of oats by merely delaying the time of application of nitrogenous fertiliser (2).

An investigation on the characterisation of potato tubers by chemical and physico-chemical methods has been restarted.

The investigation with the Advisory Bacteriology Department on the nature of the changes which take place in the A.I.V. process is being continued (3).

The work on the hardness of milk curd and on the composition of milk from the Shothead herd is being continued.

The investigation which was carried on for four years on the composition of pasture and the effects of manuring has also been completed and the results are being examined statistically.

In last year's report reference was made to the investigation which had been started on the composition of poultry manure; this work is still in progress.

Titles of papers issued during the year.

1. Smith, A. M.: Some observations on the *Aspergillus niger* method. *Trans. 3rd Inter. Cong. Soil Sci.,* **1,** 171-173, 1935.
2. ———: The uptake of nitrogen by oats under different conditions. *Ibid.,* **1,** 210-212, 1935.
3. Cunningham, A., and Smith, A. M.: Studies on A.I.V. silage. *Soc. of Agric. Bacteriologists,* July, 1935.

58. GLASGOW: WEST OF SCOTLAND AGRICULTURAL COLLEGE

A study of the relationship between the chemical constitution of basic slags and their relative efficiency as phosphatic fertilisers has been continued during the past year. Tests have been made of the relative values of four slags whose citric solubility varied from 20 to 80 per cent.

The Scottish 1934 experiments (1) showed that low soluble slags were capable of greatly increasing the yields of swedes especially under the special conditions of soil and climate in south-west Scotland.

The effectiveness of the slag increased with increasing solubility as measured by the citric acid test, but the increase was not proportional to the increase in solubility.

At some centres it was observed that the response to phosphates has not been as satisfactory as had been anticipated from the results of soil analysis. This aspect of the problem is receiving attention along with the more general question of correlation of laboratory tests with field trials.

The work upon milk and cheese has been continued. The biochemical changes associated with the organic and protein constituents of various types of cheese during ripening are being studied.

Amongst the crops used in feeding trials at Auchincruive, Marrow Stem Kale and Sugar Beet tops were of sufficient interest to warrant attention. The composition of these feeding stuffs was determined during the winter months (2).

A modification of the Bray-Herzner method for the determination of available potassium has been tried and gives promise of being satisfactory (3).

A tentative scale of potash and phosphate requirements on the basis of the laboratory examination has been formulated and joint experiments are being conducted at several centres throughout the College area. The manuring is based upon the analytical data obtained for the soil of the field in which the trial is being conducted.

Titles of papers issued during the year.

1. Permanent Committee on Basic Slag: Scottish Experiments, 1934; 13th Int. Rep., *Min. Agric.*, 17-27, Sept., 1935.
2. Paterson, W. G. R.: Some substitutes for swedes in beef production. *Agric. Prog.*, **12,** 103-109, 1935.
3. Whittles, C. L.: The Bray-Herzner method for the determination of available potash in soils.

ENTOMOLOGY

59. ABERYSTWYTH: UNIVERSITY COLLEGE OF WALES

In collaboration with the Advisory Mycologist, a survey has been made of hill farms in Cardiganshire, Pembrokeshire and Merionethshire, where conditions were likely to be favourable for the production of virus free seed potatoes. On many of these farms, although the same seed has been kept for varying periods up to twenty years or more, vigorous crops are still being obtained, and even though rogueing has not been carried out, virus diseases are practically absent.

Provisional centres have been agreed upon for next year's programme, which will include the use of Scotch and Welsh grown seed, as well as stocks of seed which have been built up at Aberystwyth from strains apparently possessed of a considerable degree of resistance to virus diseases.

The survey of districts affected with potato eelworm was continued and new centres of infection recorded. The manurial balance of infected soils as compared with that of non-infected soils of the same type and in the same locality is now being enquired into.

The occurrence, distribution, and bionomics of the Cecidomyidae of grasses have been further studied, mainly in Cardiganshire and Montgomeryshire.

Seventeen species in all have been recorded. Seven of these have been described previously, three have been recorded without full description or identification, and the remaining seven are apparently species new to science. It has been found that Montgomeryshire is far richer both in species and in numbers, than is Cardiganshire, and it is thought that climatic conditions may be the governing factor. Altitude also appears to limit the distribution of some species.

The occurrence of the Timothy flies *Amaurosoma armillatum* and *A. flavipes* has also been studied. Hitherto these species have been much confused, and an attempt has been made to clarify the position. The larval anatomy of the latter species, hitherto incompletely described, has been investigated.

A new species of *Phytomyza* mining the leaves of Yorkshire Fog has been recorded, and the larval anatomy is being studied.

A further series of observations has been made on the bionomics of *Apion* weevils of red clover. The part played by altitude as a factor limiting the incidence of these weevils has been studied, and arrangements made for carrying out experiments on their control during the coming season.

Investigations into the cestode parasites of birds have been continued, and have been extended to include also the trematode parasites. Birds belonging to twenty-five species have been examined for parasites. Fifteen known species of cestodes have been recorded, one genus new to science has been recorded and named *Progynocestus*.

Six species of *Hymenolepis* new to science, one of *Anomotaenia* and one of *Aploparaksis* have been recorded.

Seventeen known species of bird trematodes have been recorded.

The zoological survey of hill farms and sheep walks referred to in the annual report for 1933-34 was carried out regularly during the winter and spring of 1934-35, and subsequently as pressure of other work permitted.

60. BANGOR: UNIVERSITY COLLEGE OF NORTH WALES

Ecology of aphides infesting the potato crop.—Experiments have shown that the percentage of migrating winged *Myzus persicae* infected with virus diseases of potato is particularly small when first arriving on potato crops, even in districts where the spread of such is rapid.

Winged aphides readily discover and populate isolated healthy potato plants.

A water-power mechanical insect trap was designed for the study of factors affecting flight of aphides. Migrations were few during 1935, but the effect of wind, humidity and temperature upon flight was clearly demonstrated.

Laboratory studies showed the marked effect of wind velocity in inhibiting flight of *Myzus persicae*.

Collembola.--Studies of the morphology of certain Collembola during the stages of life-history have been made as basic to systematic work.

Identification of economic species and of collections from expeditions has been completed.

Control of flea beetles.—Seed treatment with several chemicals proved ineffective. Dusting of seedlings with slate dust plus repellents was promising.

Fumigation of rabbits.—Trials showed that fumigation with a cheap proprietary form of calcium cyanide was efficient for the control of the rabbits.

Production of strawberry runners.—Advantage has been taken of the comparatively aphis free districts in North Wales for the introduction and production of healthy strawberry runners.

Titles of papers issued during the year.

1. Davies, W. Maldwyn: The Percy Sladen and Goodman Trusts Expedition to the Islands in the Gulf of Guinea. October, 1932-March, 1933. IV. Collembola. *Ann. Mag. Nat. Hist.*, 10, **15**, 146-150, Jan., 1935.
2. ————: Studies on aphides infesting the potato crop. III. Effect of variation in relative humidity on the flight of *Myzus persicae* Sulz. *Ann. Appl. Biol.*, **22**, 1, 106-115, Feb., 1935.
3. Davies, W. Maldwyn, and Whitehead, T.: Studies on aphides infesting the potato crop. IV. Notes on the migration and condition of alate *Myzus persicae* Sulz. *Ibid.*, **22**, 3, 549-556, Aug., 1935.
4. ————: The Collembola from the South Orkney Islands. *Discovery* Reports, **10**, 379-380, 1935.

61. BRISTOL UNIVERSITY

Investigations on the behaviour and control of the eelworm Heterodera schachtii.—This was continued, in conjunction with the Advisory Mycologist, and included field, greenhouse and pot trials with both pea and potato strains.

Calcium cyanamide again gave an excellent result as regards growth and crop, although the eelworm infestation was not apparently reduced.

It was found that Brussels sprouts interplanted with peas became lightly infested.

The control of flea beetles by means of a seed dressing.—Trials were again carried out, on a farm scale, at a number of centres, and favourable results were obtained both as regards protection from infestation, and an increased number of seedlings on the dressed plots.

The cost worked out at not more than 2d. per acre, for materials used.

The cause of " gadding " in cattle.—These observations show that the blood sucking Tabanid fly, *Haematopota pluvialis*, is the main cause on the group of Somerset farms used.

The control of Contarinia pyrivora, the pear midge.—A further attempt was made at three centres, using a pre-blossom derris wash. The counts were ruined by the May frost, but it was obvious that the spray was not successful.

The oat eelworm (Anguillulina dipsaci).—Work was commenced upon an investigation of the sources of infestation, whether due to infested soil or seed. The history of infested fields and suspected seed grown on them was followed up, and seed from infested crops collected for trials.

The control of wireworms in field crops.—A series of trials was arranged to test the value of calcium cyanamide for this purpose.

Titles of papers issued during the year.

1. Walton, C. L.: The control of *Phyllopertha horticola* L. in grassland. *Ann. Rep. Agric. & Hort. Res. Sta.*, Long Ashton, 150-157, 1934.
2. ———: The control of an infestation of *Pseudococcus Gahani* Green. *Gard. Chron.*, 357, 17th Nov., 1934.
3. An investigation of diseases and pests of hops. *Prog. Rep. Worcs. C.C. Agric. Quart. Chron.*, **3**, 2, 85-89, Feb., 1935.
4. The chafer beetles and their control. *Ibid.*, **3**, 4, 213-215, Aug., 1935.
5. Walton, C. L., Ogilvie, L., and Mulligan, B. O.: The effect of calcium cyanamide and of formalin on pea sickness. *Prog. Rep. Ann. Rep. Agric. & Hort. Res. Sta.*, Long Ashton, 158-161, 1934.
6. Walton, C. L., and Kearns, H. G. H.: The chrysanthemum eelworm and its control. *Worcs. C.C. Agric. Quart, Chron.*, **3**, 1, 25-31, Nov., 1934.
7. Walton, C. L., and Ogilvie, L.: Pea sickness. *Ibid.*, **3**, 3, 151-153, May, 1935.

62. CAMBRIDGE UNIVERSITY

Control of flea beetles.—Further experiments on the control of flea beetles in brassicae seed-beds showed that both derris dust and naphthalene silica dust are capable of saving seed-beds if special care is taken in the times of application. At two centres these dusts gave equally good results, but at a third centre derris dust was decidedly the better.

Control of plum sawfly.—Experiments showed that two sprayings with derris + a spreader and nicotine sulphate, lead arsenate + a spreader gave equally good results on the control of the pest. Nicotine sulphate alone gave disappointing results.

Control of wireworm.—Some preliminary experiments were carried out on the value of certain cultural operations as a means of reducing damage caused by wireworm to sugar beet.

Control of cabbage aphis.—Further observations on this pest were carried out in co-operation with the Horticultural Research Station. Brassicae grown for seed or allowed to run to seed were the main source of overwintering of the aphis. Observations show that this pest is very difficult to control by spraying or dusting, and it is strongly suggested that seed growers should be compelled to take steps to control this pest on their seed plants.

Control of cutworms or surface caterpillars.—Experiments showed that this pest is readily killed by means of a poison bait if applied when the caterpillars are small.

Titles of papers issued during the year.

1. Petherbridge, F. R.: Beet sickness present in England. *J. Min. Agric.*, **41,** 9, 825-827, Dec., 1934.
2. Petherbridge, F. R., and Stirrup, H.H.: Pests and diseases of the sugar beet. *Min. Agric.* Bull. No. 93.
3. Petherbridge, F. R., and Thomas, I.: The control of flea beetles in seed beds. *J. Min. Agric.*, **41,** 11, 1070-1078, Feb., 1935.

63. CARDIFF: UNIVERSITY COLLEGE OF SOUTH WALES

Control of cabbage root-fly (*Chortophila brassicae*).—This pest can be successfully controlled by the use of mercuric chloride solution. As this substance is extremely poisonous, trials have been carried out with non-poisonous materials. The following were tested: a tar-distillate fruit-tree wash (1 fluid oz. per gall.); magnesium sulphate (8 oz. per gall.); borax (⅓ oz. per gall.). Three applications of ¼ pint per plant were made at ten-day intervals; the test crop was cauliflowers. Results indicated that all three treatments gave a substantial measure of control, borax and tar-distillate being somewhat superior to magnesium sulphate.

Mustard beetle (*Phaedon cochleariae*).—This beetle has become a serious pest to watercress growers in South Wales. The results of extensive trials of derris powders are not yet fully analysed, but it is clear that derris dust of 5 per cent. guaranteed rotenone content gives effective control.

Chrysanthemum capsid (*Lygus pratensis*).—This insect, whose life history and habits are as yet unknown in detail, has increased rapidly in recent years as a pest of commercial growers. Extensive observations have been made during 1934-5, with a view to elaborating control measures. Derris root dust of 0·2 per cent. rotenone content has proved a promising means of control.

Potato eelworm (*Heterodera schachtii*).—" Potato sickness " due to this pest, is very serious in Glamorgan and Monmouth. The following soil treatments were tested:

(i) Sulphate of potash, 4 oz. per square yard, raked into the soil a fortnight before planting.

(ii) Calcium cyanamide, 3 oz. per square yard, raked into the soil a fortnight before planting.

(iii) Commercial powdered naphthalene, 4 oz. per square yard, dug into the surface soil ten weeks before planting.

(iv) A liquid proprietary " soil steriliser ", applied ten weeks before planting.

Substantial improvements in crops were given by all treatments: at one centre the crop from the cyanamide plot, which was the best, was over six times as much as that from the control plot. . . . .

Titles of papers issued during the year.

1. Edwards, E. E.: Further experiments (1934) on the control of the cabbage root fly. *J. Min. Agric.*, **42,** 1, 34-38, Apr., 1935.
2. ————: The pigmy mangold beetle: A serious pest of sugar-beet and mangold crops. *Ibid.*, **42,** 2, 148-154, May, 1935.
3. ————: On the *Heterodera schachtii,* with special reference to the oat-race in Britain. *J. Helminth.*, **13,** 2, 129-138, May, 1935.
4. ————: Insect pests of vegetable crops I. *West. Mail Ann. Agric. Suppl.*, Feb., 1935.
5. ————: Leather-jackets and their control. *West. Mail,* April, 1935.

64. LEEDS UNIVERSITY

Potato eelworm (*H. schachtii*).—The potato eelworm plot trials at North Cave have been continued. Tests have been made of the effects of mercuric chloride at strengths of 1 in 250 and 1 in 500, dressings of sulphate of potash at different rates, and also of rape meal. An additional trial of sulphate of potash at 12 and 15 cwt. per acre was put down at Cookridge, near Leeds. At neither centre did such dressings have any appreciable effect on the attack or result in any marked increase in crop.

Tomato eelworm (*H. schachtii*).—Observations on attacks by the tomato strain of this eelworm have been made at numerous centres, and the effects noted of replacement of soil and of steam sterilisation on the incidence of attack. Change of soil to a depth of 6 inches was followed by severe attack in infested greenhouses. Where the soil was dug out to a depth of 15 to 18 inches and all walls, etc., thoroughly cleaned, a satisfactory crop was obtained, but quite considerable eelworm attack and cyst formation occurred.

Steam sterilisation gave control of the pest.

Mercuric chloride gave an improved crop but did not control the pest.

In connection with the preceding tests it is interesting to note that attacks on tomato occur where it is common practice to apply dressings exceding 1 ton per acre of sulphate of potash.

Wireworm control.—A field trial for the prevention of wireworm injury to potatoes was carried out at Sheriff Hutton. Crude naphthalene at the rate of 2 cwt. per acre—spread in the rows under the dung before planting—was estimated to increase the saleable crop by 1 ton per acre. Fully half the tubers on the untreated area were holed, those on the treated area being much less attacked.

The control of Pharaoh's ant.—Trials for the control of the household ant *Monomorium pharaonis* have been made at several centres. A poison bait made of sugar and honey syrup poisoned with thallium sulphate has proved effective in controlling this and other species of ants invading houses.

Control of strawberry pests.—Departmental trials have been continued in the Cottingham area on the control of various strawberry pests. Observations have been made on the effect of (i) the hot water treatment of runners, and (ii) mineral oil washes.

Winter spraying.—Observations were made on winter spraying demonstrations caried out in the Goole area. Trials were intended to demonstrate the effect of a routine spraying programme on neglected orchards.

Title of paper issued during the year.

1. Thompson, H. W.: Plant pests in Glamorgan. III. *Trans. Cardiff Nat. Soc.*, **66**, 1935.

65. MANCHESTER UNIVERSITY

The change in number of viable eelworm cysts in infested soil when potatoes are omitted from the rotation.—Investigation has shown that there is a steady decrease in the number of viable cysts for five years after the last potato crop, but that thereafter the rate of decrease is consistently less. By the end of seven years the viable cyst content is as low as 17·5 per cent. of the original viable cyst content taken immediately after the removal of a heavily infested potato crop. This suggests that after an interval of seven years on infested land potatoes can again be included in the rotation provided a wide rotation is adopted.

The wireworm problem.—On the lighter soils both farm crops and market-garden crops grown on the farms are subject to serious wireworm attack. In normal circumstances wireworm infestation steadily decreases under arable cropping, but the local practice of including short leys in the rotation appears to be an important factor in maintaining heavy infestation by wireworms. From a study of farmers' experiences these leys appear to be necessary to the proper maintenance of fertility and hence wireworm control becomes of considerable importance.

Spraying with tar-distillate for the control of plum and damson pests. Winter spraying with a 7 per cent. tar-distillate at certain centres in North Lancashire in early January has been continued during the year. The trees which have now received treatment for three successive seasons show a marked improvement in health and vigour over untreated trees. Foliage is more prolific and healthier, the fruit crop is heavier and the individual fruits of larger size as a result of the treatment.

Control of chrysanthemum leaf miner.—The chrysanthemum leaf miner (*Phytomyza atricornis*) is an important pest in the market gardening areas of Lancashire and Cheshire. Biological studies show that though the species is subject to a high degree of parasitisation this factor is not normally operative during the period of greatest susceptibility of the host plant. Control measures are therefore necessary and in preliminary trials of wet sprays containing nicotine and dry dusts containing nicotine, sulphur and naphthalene have been made. So far, nicotine as a wet spray and with a suitable wetting agent has proved very successful in reducing infestation.

Titles of papers issued during the year.

1. Miles, H. W.: Control of insect pests of vegetable crops. *Sci. Hort.*, **3**, 126-132, 1934.
2. ———: The *Hymenoptera Symphyta* (sawflies) of Lancashire and Cheshire. *Ann. Rep. Lancs. and Ches. Faunal Comm.*, **20**, 39-43, 1934.
3. ———: Control of flea beetles with a naphthalene-silica dust. *J. Min. Agric.*, **41**, 1079-1083, 1935.
4. ———: Biological studies of certain species of *Caliroa costa* and *Endelomyia* Ashmead. *Ann. Appl. Biol.*, **22**, 116-133, 1935.
5. ———: The plum fruit sawfly and its control. *J. Min. Agric.*, **42**, 129-133, 1935.
6. ———: On the biology of certain species of *Amauronematus* Kon. *J. Linn. Soc. Zool.*, **39**, 266, 295-306, 1935.
7. Miles, H. W., and Cohen, M.: The glasshouse symphilid and its control. *J. Min. Agric.*, **42**, 450-457, 1935.

66. MIDLAND AGRICULTURAL COLLEGE

Bird damage.—Experimental feeding of rooks to ascertain the amount of food consumed has been continued. Attention has been directed to the " grazing " of wheat during the winter, which in some cases destroyed the crop completely.

The investigation of the damage caused to winter wheat by larks has been continued, but without conclusive results. It has become clear that the larks are particularly attached to certain restricted areas, and cause intensive damage to wheat on these areas.

Sugar beet pests.—Cutworms (mainly *Euxoa segetum*) and millipedes (*Blanjulus guttulatus*) are notable among these. In addition a fairly widespread disease of puzzling nature but not causing serious damage has been found. This took the form of the discoloration and swelling of short lengths of the main veins or petiole, first appearing in August, and enlarging to rupture in September. The appearances suggest a gall, but no pest could be found responsible.

Pulse crop pests.—A field test against *Sitona lineatus* was carried out, and smaller trials against the pea aphis

(*Macrosiphum pisi*) and pea moth (*Cydia nigricana*). In one test pyrethrum wash gave good control of pea midge (*Contarinia pisi*).

Soil pests.—Carrot fly (*Psila rosae*) has been scarce in the fields though abundant in gardens: it seemed to prefer celery to carrots. Experiments have been continued on the control of wireworm, potato eelworm, and millipede, without revealing any control method. Millipedes seem to be attached to specific fields or parts of fields.

Cabbage pests.—Work has been commenced on a pest new to the Province, the cabbage stem flea beetle, *Psylliodes chrysocephala*. Both larvae and adults have caused severe damage to cabbage crops, and an attempt has been made to restrict its range for the season 1935-6.

Miscellaneous.—A study of the snails present in a watercress farm showed them to be harmless.

The carnation fly (*Hylemyia brunnescens*) occurred as a leaf miner on sweet williams, but the adults which emerged died without laying eggs.

Titles of papers issued during the year.

1. Roebuck, A.: A year in the life of a pet rook. *The Countryman*, **10,** 1, 126-128, 1934.
2. ————: A general account of the pests on willows. *J. Animal Ecol.*, **3,** 2, 182-186, Nov., 1934.
3. ————: The rotation of crops. Its relation to sugar beet pests and diseases. Beet sickness or eelworm. *Sugar Beet Ann.*, 69-75, 1935.
4. ————: The mealy cabbage aphis. *Derbyshire Farmer*, **15,** 2, 58-60, Feb., 1935.
5. ————: Lincolnshire duck decoys. *Lincs. Mag.*, **2,** 5, 134-138, 1935.
6. Roebuck, A., Cranfield, H. T., and Stafford, J. G. W.: The control of mites in cheese stores. *Midland Coll. Bull.* No. 33, Dec., 1934.

67. NEWCASTLE: ARMSTRONG COLLEGE, DURHAM UNIVERSITY

Trials were carried out on $\frac{1}{4}$ acre plots on newly ploughed out old grass land sown with oats, in order to test the effect of certain treatments against wireworm.

Extra seeding gave the best results. On one plot which received basic slag at the rate of 10 cwt. per acre, the dressing helped the oats to " grow away " from the attack, but no insecticidal effect was observed. The trial with Paris-green, which was applied as a dressing followed by harrowing, was not successful in attracting and killing the wireworm. Salt applied to a plot was distinctly harmful to the soil and to plant growth, and it had the effect of retarding the ripening of the crop. Kainit, also, did not give encouraging results.

Orthodichlorbenzene was tried against flea beetle on portions of drills of swedes. No good results were noted and germination was retarded.

Raspberry beetle (*Byturus tomentosus*).—Trials against this pest indicated that the most efficient control was obtained by the use of derris and barium silico-fluoride washes. The derris fluid spray showed more uniformity in action as compared with liquid barium silico-fluoride.

Title of paper issued during the year.

1. Gray, R. A. H.: Spraying trials against the raspberry beetle (*Byturus tomentosus* Fab.) *J. Roy. Hort. Soc.*, **60**, 8, 1935.

68. READING UNIVERSITY

Yellow stripe in narcissus.—This " virus " problem continues under investigation. Incidence in observed plots at Reading suggests that it may be artificially spread by way of infected wounds. Further experiments have been laid down with a view to confirming this impression.

The stem and bulb eelworm.—Studies of this pest have been continued.

Lily pests.—The study of pests affecting lilies in commercial plantations and houses has continued. In particular the bionomics of the lily thrips, *Liothrips vaneeckei*, have been investigated. Control by means of fumigation has been found effective.

Chrysanthemum leafy gall.—A joint investigation with the Mycologist of this very serious complaint which inhibits the production of cuttings, and may be a bacterial disease, continues.

Root eelworm (*Heterodera schachtii*) *in cereals.*—Field experiments to determine a range of safe alternative crops on infected land are in progress.

Aphis in oat.—Attempts are being made to elucidate the life cycle of the aphis, *Myzus festucae*.

Titles of papers issued during the year.

1. Hodson, W. E. H.: Eelworm menace to the potato crop. *Farmers' Weekly*, **2**, 13, March, 1935.
2. ————: Cabbage root fly. *Ibid.*, **2**, 16, April, 1935.
3. ————: Control of insect pests of bulbs. A survey of recent work. *Sci. Hort.*, **3**, 192-196, 1935.
4. ————: Pest and disease control in glasshouse soils. *Estate Mag.*, **34**, 12, 931-934, 1934.
5. ————: Eelworm under glass. *Fruitgrower*, **79**, 558, Oct., 1934.

69. SEALE-HAYNE AGRICULTURAL COLLEGE

Bulb scale mite (*Tarsonemus approximatus var. narcissi*).—Further work has been carried out on short period hot water treatment prior to forcing of bulbs. The experiments have largely been carried out on the variety Golden Spur and treatments up to one hour in duration have not affected the quantity or quality of flowers adversely. Such treatments are longer than are necessary to control all stages of the pest.

Bulb flies (*Merodon equestris and Eumerus spp.*)—Several field experiments were laid down to test the lime and creosote dust tried in previous years. The lime and creosote dust is in effect a naphthalene dust, but being made from lime and crude creosote it can be manufactured much more cheaply than from naphthalene itself. The dust is deterrent in action.

The dust was modified in its constituents so as to render it more lasting in its effect. Saturated crude creosote was used and the percentage of the creosote was increased from 10 per cent. up to 20 per cent.

Violet leaf and flower aphis (*Myzus ornatus*).—Work on this pest has been concentrated in an attempt to find some means of dealing with the aphis after the violet plants have commenced to flower. Nicotine sprays, in addition to the difficulty of reaching aphides inside half open flowers, have been found to check flowering. Small trials carried out with fine calcium cyanide dust give promise of proving effective, but further trials are necessary in order to find a suitable diluent. The cost of the dust makes this essential and it has also been found that the pure dust has a tendency to scorch. Still conditions are required for the dust to be fully effective and the plants should be quite dry.

Violet eelworm (*Aphelenchoides olesistus*).—Further experiments in the hot water treatment of runners have been carried out, with the object of freeing plants from eelworm. In previous years the results have been very variable and it is now realised that this was the result of uneven heating in the bath.

In later treatments a check has been kept on these temperatures by means of thermocouple apparatus.

Results have been greatly improved and the percentage of plants killed by the treatment has been much reduced. It is clear, however, that the violet plant is a difficult subject for hot water treatment and it is not considered safe to make any definite recommendations to growers.

Work on strawberries.—In view of the large amount of work being carried out at various research stations and advisory centres, and having regard to the fact that this work has now largely developed along the lines of virus diseases, the investigations have become concentrated on the problem of the hot water treatment of runners.

It has already been determined that the problem of heating a large number of strawberry runners evenly through to a temperature of 110° F. is on the whole a much more difficult problem than in the case of narcissus bulbs, largely as the result of the tendency of runners to pack together and cause marked temperature " blanketing " either below or above 110° F.; temperature differences of over two degrees have been observed. The results of this work will also be applicable to the treatment of violet runners.

Potato " sickness " (*Heterodera schachtii*).—Further experiments on the hot water treatment of seed potatoes, as a means of freeing seed from the eelworm cysts, have been made. The treatments given were for periods of twenty minutes and one hour on 26th and 27th March. Owing to the late date of treatment as compared with the previous year's experiments (28th January) the sprouting was checked with the result that growth was later and the crop smaller than the untreated.

Title of paper issued during the year.

1. Staniland, L. N.: Entomological section. Eleventh Report. *Dept. Plant Path. Seale Hayne Agric. Coll.*

70. WYE: SOUTH-EASTERN AGRICULTURAL COLLEGE, LONDON UNIVERSITY

Strawberry blossom weevil (*Anthonomus rubi*).—Tests of insecticidal substances against this weevil have been confined to insectary trials, carried out on a larger scale than in previous years, in order to obtain more certain evidence upon the toxic value of derris and pyrethrum dusts. Results, which have now been accumulated for three years, show that even under conditions favouring the maximum toxic action of the dusts, their effect is not very marked and it is doubtful if they can be expected to give a satisfactory control in the field. The field trials in previous years indicated that derris dusts did not bring about an appreciable reduction of attack.

Blackcurrant eelworm (*Aphelenchoides ribes*).—A field trial was carried out at Chailey, Sussex. Observations made previously in the laboratory gave an indication of the period during which eelworms moved from old dead buds to fresh ones. A nicotine-petroleum oil emulsion was then applied to blocks of bushes in an attempt to destroy the migrating worms. Several different blocks of bushes were treated at intervals but it will not be possible to assess the results until next spring when bushes commence to make fresh growth.

Fumigation against grain-feeding beetles.—Fumigation was carried out in a granary at Lydd where a large bulk of grain was heavily infested with weevils, *Calandra granaria, C. oryzae,* and several other species of beetles. Checks on the effect of the fumigation were made by burying known numbers of beetles in suitable tubes at varying depths in the grain. The tubes were removed after 48 hours and the mortality estimated. In spite of the low temperature prevailing at the time, early November, a satisfactory kill was obtained but the effect of the fumigant was comparatively slow and many of the affected weevils did not die until a week after treatment.

Insect and allied pests of cultivated mushrooms.—A systematic examination of the fauna of stable manure has been continued. This in intended to provide information concerning the extent to which pests of mushrooms may be part of the natural fauna of manure and to ascertain what changes, if any, take place in the fauna during the process of composting. The investigation occupied ten consecutive months and showed that Sciarid flies exist in manure and may be present in considerable numbers as larvae when the compost is laid down in beds.

The value of nicotine sprays against the eggs and larvae of one of the more important Sciarid flies, *Sciara fenestralis,* was the subject of laboratory tests. Two " wetters " for use with nicotine were also tried and found to be harmless to growing mushrooms, whereas soap is highly injurious. A proprietary oil emulsion was also tried for its effect upon Tyroglyphid mites attacking mushrooms. Work on the identity of some of these mites has been commenced.

Hop Red Spider (*Tetranychus telarius L.*).—A number of trials on pot plants were carried out to test the toxicity of certain spray fluids not fully investigated last year. Of the washes tested, lime sulphur and petroleum oil emulsions were the most effective. Washes containing derris and pyrethrum extracts, at concentrations advised by the makers, showed little toxicity and a Bordeaux mixture-cottonseed oil emulsion was similarly ineffective.

Lime sulphur at a strength of 1 in 80 was applied to several acres of hops in addition to the usual applications of Bordeaux mixture. Infestation by the mite was not heavy this season, but the attack appeared to be very well controlled and no injurious effect upon the foliage was noted from the interaction of Bordeaux mixture and lime-sulphur.

Pyrethrum.—The severe frost in May caused great injury to flower buds on the experimental plot and it was estimated that about 50 per cent. of the buds failed to mature or produced only very mis-shapen flowers. The remainder were abnormally small and the weight of crop was much less than usual. The very irregular period of flowering also caused difficulty in harvesting and flowers had to be entirely hand-picked as they matured. The plot has now been standing for seven years and it is considered that no further useful data can be obtained from it; it will therefore be ploughed up. Work on the six selected types, commenced last year, has been continued in co-operation with the Botanical Department. It is now proposed to propagate the selected types vegetatively and eventually obtain small plots of each type to study their relative merits from the point of view of cropping capacity, suitability for mechanical harvesting and pyrethrin content.

Weevils of the Genus Rhynchites.—A study of three species, *Rhynchites aequatus, R. coeruleus* and *R. germanica,* the first two of which attack apple and the other occurs on strawberry, has been commenced.

Titles of papers issued during the year.

1. Austin, M. D., Jary, S. G., and Martin, H.: Control of the common green capsid bug with special reference to the use of tar-petroleum oil winter washes. *J. Min. Agric.,* **41,** 1195-1205, March, 1935.
2. Jary, S. G.: Some observations upon the red spider (*Tetranychus telarius* L.) on hops and its control, with notes on some predatory insects. *Ann. Appl. Biol.,* **22,** 3, 538-548, August, 1935.

71. ABERDEEN: NORTH OF SCOTLAND COLLEGE OF AGRICULTURE

Greenfly investigation.—The species and numbers of greenflies (Aphididae) found on potatoes of selected varieties grown in the Outer Hebrides and Shetland, are being investigated in collaboration with the Agricultural Botany Department which examines the plants for virus and other diseases.

Cabbage root fly.—Control of this insect attacking field crops of turnips and swedes was attempted with a mixture of ortho- and para-dichlorobenzene broadcast by hand at the time of the first hoeing, but the results of the experiments are not known yet.

Turnip flea beetle.—Turnip fly (*Phyllotreta undulata* Kuts.) seed treatment with liquid orthodichlorobenzene was tried on an extensive scale, but the favourable weather for growth experienced by the earlier sown turnips and swedes rendered the experiments inconclusive. Late sown turnips and swedes in some districts suffered from the above-ground attack of flea beetle and experiments to repel this attack by scattering a mixture of ortho- and para-dichlorobenzene along the rows of young plants, seemed promising till heavy rain nullified them by enabling the young plants to grow away from attack.

Sheep maggot fly.—In conjunction with the Zoology Department of Aberdeen University and the Rowett Research Institute the sheep maggot flies are being investigated with the intention of finding more satisfactory methods of control than those usually adopted at present.

Insecticides.—Various insecticides have been tested on white-fly, greenfly, apple sucker, red spider, gooseberry sawfly and other insects.

Title of paper issued during the year.

1. Morison, G. D.: Insects swept out to sea by a spate. *Scott. Naturalist*, 37-38, 1935.

72. EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE

Investigation of the biting horse-flies (*Tabanidae*) has been continued and much useful information has been obtained on the habits and life-histories of British species not hitherto studied (1, 2).

An investigation of the habits and life-history of the Douglas fir chermes (*C. cooleyi*) in Scotland was begun. Results of first-class importance have already been obtained concerning the generations of this important forestry pest, that occur on Sitka spruce. For the first time in Britain the galls produced by this insect on the alternative host, have been discovered and it has been established that the individuals emerging from the galls on the spruce return to the Douglas fir. The whole life-cycle has been worked out, but several interesting problems have arisen in the course of the investigation which will require further study.

An investigation of cabbage root flies has been commenced by collection of information on their distribution and abundance.

Enquiry into the slug pest of potatoes in the Lothians is being actively carried on. A study is being made of the various climatic and soil factors affecting slugs in order to discover, if possible, what modifications of agricultural practice may be introduced that will cope effectively with the pest without adversely affecting the yield of the crop. There is evidence that damage to the potato crop may be reduced by the provision of attractive alternative food plants, such as grass, grown with the crop.

Titles of papers issued during the year.

1. Cameron, A. E.: The life-history and structure of *Haematopota pluvialis* Linne. *Trans. Roy. Soc. Edin.*, **63**, 211-250, 1934.
2. ———: Insect pests of 1934. *Trans. Highland Agric. Soc.*, **47**, 94-118, 1935.

73. GLASGOW: WEST OF SCOTLAND AGRICULTURAL COLLEGE

Potato root eelworm (*Heterodera schachtii*).—None of the materials tested as control measures had any marked effect. The only practicable method seems to be adherence to a rotation in which potatoes occur not more often than once in three years.

A census of eelworms and eelworm cysts in Ayrshire potato soils showed clearly that the eelworm population of the soil was increased by close cropping.

MYCOLOGY AND BOTANY

74. ABERYSTWYTH: UNIVERSITY COLLEGE OF WALES

Bunt (*Tilletia caries*) *in wheat.*—The results obtained this year show that wet treatments are more efficient than dry treatments in controlling bunt in a heavily infected crop. They show also that mercuric dusts vary considerably in their efficiency against the same disease as shown by the following figures:—Untreated—77 per cent. bunted ears; R.D. 3715—32 per cent.; R.D. 3963—25 per cent.; $CaCo_3$—20 per cent.; mercuric dust A—13 per cent.; formalin—8 per cent.; mercuric dust B—5 per cent.; and copper sulphate—3 per cent.

R.D. 3715 and 3963 are special brands of mercuric dusts.

Covered smut (*Ustilago Kolleri*) *in oats.*—Last season no satisfactory control of covered smut was obtained, but in similar trials this year one sample of mercuric dust practically eliminated the disease, and the following figures show the beneficial effect of this particular dust treatment:—Untreated—16·3 per cent. smutted; R.D. 4313—6·4 per cent.; R.D. 4314—5·6 per cent.; R.D. 3699—2·3 per cent.; formalin—2·3 per cent.; and mercuric dust B—0·1 per cent.

Loose smut of wheat. Further trials against loose smut of wheat (*U. tritici*) show the beneficial effect of Jensen's hot water treatment. Perfect control followed the treatment with all varieties included in the trial.

Finger and toe (*Plasmodiophora brassicae*).—Mercuric chloride continues to give good control of finger and toe both against matured plants and in the seed bed. It is, however, a laborious method of treatment and it was decided therefore to test a dust or dry treatment reputed to give good results. The following figures obtained with seedling cabbages show very clearly that the dust treatment is not nearly as efficient as mercuric chloride:—Untreated plots gave 60 per cent. infected seedlings; proprietary dust—33 per cent.; and mercuric chloride—0·9 per cent.

Trials on the control of onion mildew had to be scrapped this year owing to the prolonged drought.

75. BANGOR: UNIVERSITY COLLEGE OF NORTH WALES

Finger and toe disease.—Trials to investigate the observed irregularity of the effects of liming on this disease were laid down at two centres in 1933. This work was completed in 1935. The results indicated, though not conclusively, that the effect of lime was a direct one on the spores, rather than an indirect one through raising the pH of the soil. A substantial residual effect of previous lime dressings was found after two years: the lime which had by then become incorporated with the soil apparently made contact with a larger number of spores, thereby producing an effect as great as the immediate effect of much heavier dressings.

The order of susceptibility of various plants in the extremely heavily infected ground used, was roughly: cauliflower, cabbage, (susceptible swede), savoy, Brussels sprouts, (resistant swede), (yellow turnip), (marrow-stemmed kale). Plants in brackets were not included in this particular trial.

Even with heavy dressings of lime the percentage of infection in the trials ranged from 50-100 per cent., and it seems clear that on such heavily-infected soil lime cannot be recommended as a control measure.

Swede investigations.—Trials have been in progress for several years with the object of assessing the value to the farmer of various varieties, by estimating yield, rate of maturation, and susceptibility to common diseases. In the course of a study of maturation it has been shown that it is necessary to take samples at several times for percentage dry matter, since this figure is constantly changing and its relation to yield per acre is constantly changing also. Maturation is now defined as the point at which percentage dry matter reaches a maximum. It has been found possible to draw up tables showing the trends of fresh weight and dry matter percentage through the winter, and also showing the order of susceptibility to various common diseases, and this has been done for a dozen varieties.

Trials confirmed the result previously obtained, that brown-heart can be controlled by application of borax. A dressing of 10 lb. per acre gives a control virtually as satisfactory as that obtained by any heavier dressing.

There is a well-marked difference in varietal susceptibilities to brown-heart. It is also noteworthy that in early-maturing varieties the number of roots attacked falls steadily from October to February, while the mid-season and late-maturing varieties show an increase in the number attacked, followed by a fall.

Potato virus diseases.

Copper-strip method.—This method of diagnosing degeneration in tubers has been examined for the third time. Results confirm those previously obtained—that the differences in reaction, while probably of physiological importance, are not related to virus infection.

Initial infection of healthy stock.—It has again been confirmed that only a minute percentage of *migrating* winged aphis are infected. A comparison is being carried out of the rate of infection of a crop in isolation, where the main source of infection is migrating winged aphis, with that of a healthy crop adjoining a diseased one, where the movement of infected wingless forms may be important.

The carrier problem.—Trials were set up in 1934 to test the danger of planting " carrier " varieties (i.e. varieties which are invariably infected with some particular virus, although never showing symptoms) near susceptible varieties. Two carrier varieties were interplanted with three susceptible. Comparison of the latter plants and their yield with controls grown from the other halves of the seed tubers used, showed no evidence whatsoever of any transmission.

Physiology of leaf roll.—Studies have been made for some time of the osmotic relations and behaviour of healthy and diseased cells and tissues. Any abnormality in these relations may throw light on the nature of viruses, and it may also indicate cultural methods likely to minimise the effect of the virus. It has been found that

(*a*) the rate of water absorption and loss is greater in healthy than in diseased tubers, the difference increasing with length of storage;

(*b*) when free exosmosis takes place the rate of water loss from diseased tubers is greater at first, but later the healthy increase to a higher rate than the diseased.

The significance of these observations is still obscure.

Titles of papers issued during the year.

1. Whitehead, T.: The physiology of potato leaf-roll. I. On the respiration of healthy and leaf roll infected potatoes. *Ann. Appl. Biol.*, **21**, 48-77, 1934.
2. ———: The effects of varying the distance to which swedes are singled. *Welsh J. Agric.*, **11**, 228-235, 1935.
3. ———: A note on " brown-heart ", a new disease of swede, and its control. *Ibid.*, **11**, 235-236, 1935.
4. ———: The value of second-growth potato tubers for seed purposes. *Ibid.*, **11**, 225-228, 1935.
5. Davies, W. M., and Whitehead, T.: Studies on aphides infecting the potato crop. IV. Notes on the migration and condition of alate *Myzus persicae* Sultz. *Ann. Appl. Biol.*, **22**, 549-556, 1935.

76. BRISTOL UNIVERSITY

Apple diebacks, fruit spots and fruit rots.—A study has been made of the fungi occurring on apple twigs and branches and their relation to apple fruit diseases (13). The fungus *Diaporthe perniciosa* has been studied recently from this aspect.

Strawberry root rots.—Inoculations of many fungi isolated from strawberry root rots failed to produce typical rotting as it occurs in the field.

Miscellaneous strawberry diseases.—Work is in progress on the " crinkle " disease of strawberries. Hot-water treated runners of several varieties planted in greenhouse beds of soil from badly infected " crimp " fields in the Cheddar area developed severe " crimp " and " red plant " while control beds remained practically free.

Vegetable diseases.—Investigations were continued (1-10, 12, 14).

Selections of seeds of apparently resistant strains were continued for white tip of leeks and foot rot of dwarf beans.

Lettuce diseases.—Attention was concentrated this year on diseases of lettuce. The classification of lettuce varieties has been studied and it has been found that certain groups of lettuces show up mosaic symptoms much less than others.

It has again been found that certain commercial varieties are much more susceptible to *Marssonina* and *Botrytis* than others.

Mint rust.—Complete control of mint rust (*Puccinia Menthae*) in forced mint has been achieved by treatment of the runners with water at 112° F. for ten minutes prior to planting (7). Two apparently resistant strains of *Mentha villoso-nervata* are under trial.

Pea and potato " sickness ".—Trials in co-operation with the Advisory Entomologist have shown that heavy applications of calcium cyanamide enable plants to produce normal yields in soil heavily infected with *Heterodera schachtii,* but there is no appreciable reduction in eelworm infestation of the roots.

Tomato viruses.—Two new tomato viruses have been discovered in the province and have been investigated in detail at the Cambridge Virus Disease Research Station.

Resistant antirrhinum and aster varieties.—Strains of " rust proof " antirrhinums obtained from California proved highly resistant to *Puccinia Antirrhini,* and American resistant varieties of asters continued to be highly resistant to aster wilt.

Lily diseases (15).—A *Phytophthora* disease new to England, a rot associated with *Cylindrocarpon radicicola,* and a physiological flower splitting have been under observation.

Diseases of hops.—An epidemic of *Sclerotinia Sclerotiorum* on hops occurred in Herefordshire and Worcestershire in June and July. This was associated with frost injury on 17th May, and with infection of weeds in headlands, spores produced from apothecia blowing over the yards and infecting frost-injured bines and weeds. Growers were advised to uncover earthed up bines and to cut out infected ones (11).

Field observations were made on the split-leaf complex on hops, while the agents of spread of this and other virus diseases of hops are being investigated in co-operation with the Advisory Entomologist.

Titles of papers issued during the year.

1. Ogilvie, L., and Mulligan, B. O.: Vegetable diseases. A survey of recent work at Long Ashton. *Sci. Hort.*, **3**, 119, 1935.
2. Ogilvie, L., and Brian, P. W.: Diseases of market garden crops in Gloucestershire. I. Leeks and onions. *Glos. Farmer,* **3**, 1, 21, Jan.-March, 1935.
3. ————: *Ibid.*, II. Lettuce diseases. *Ibid.*, **3**, 2, 81, Apr.-June, 1935.
4. ————: Vegetable diseases in Worcestershire. VIII. Wilt of runner beans. *Ibid.*, **3**, 1, 23, Nov., 1934.
5. ————: *Ibid.*, IX. Finger and toe. *Ibid.*, **3**, 2, 75, Feb., 1935.
6. ————: *Ibid.*, X. Mosaic diseases of lettuces. *Ibid.*, **3**, 4, 215, Aug., 1935.
7. ————: Hot water treatment for mint rust. *Gard. Chron.*, **95**, 2535, 65, July, 1935.
8. Walton, C. L., Ogilvie, L., and Mulligan, B. O.: The effect of calcium cyanamide and of formalin on pea sickness. *Ann. Rep. Long Ashton Res. Sta.*, 158, 1934.
9. Ogilvie, L., Mulligan, B. O., and Brian, P.W.: Progress report on vegetable diseases. VI. *Ibid.*, 175, 1934.
10. Walton, C. L., and Ogilvie, L.: Pea sickness. *Glos. Farmer,* **3**, 3, 161, May, 1935.
11. Ogilvie, L., and Savidge, C.: Hop-wilt caused by the fungus *Sclerotinia Sclerotiorum. Hereford C.C. Agric. Quart. J.*, **3**, 3, 125, Sept., 1935.
12. Ogilvie, L.: Spotted wilt of tomatoes and its control. *Ann. Rep. Long Ashton Res. Sta.*, 170, 1934.
13. ————: The fungus flora of apple twigs and branches and its relation to apple fruit spots. I. *J. Pomol. and Hort. Sci.*, **13**, 2, 140, June, 1935.
14. ————: Diseases of market garden crops in Gloucestershire. III. Diseases of peas. *Glos. Farmer,* **3**, 3, 153, July-Sept., 1935.
15. ————: Notes on some diseases of *Lilium longiflorum. Roy. Hort. Soc. Lily Yr. Bk.*, 3, 91, 1934.

77. CAMBRIDGE UNIVERSITY

Seed disinfection.—Seed disinfectants have been prepared containing various organic mercury salts. In the field the best of these has given a very good control of leaf spot and smut of oats, leaf stripe and covered smut of barley, and bunt of wheat. No evidence has been obtained that—in the sense of tonic effect—crops are stimulated when dressed with seed disinfectants containing mercury. The instances of better germination, growth and crop yields are thought to be due not only to the control of seed-borne organisms, but to the preservation of the food reserve in the seed from the attack of soil organisms or mould organisms adherent to the seed.

In the series R-Hg-X, where R is a hydrocarbon and X an acidic radicle, the fungicidal power appears to decrease with the increase of the molecule of R. The phytocidal effects of salts in this series has been studied, also their vesicant action, and relative toxicity as compared with mercuric chloride.

The disinfection of seeds other than cereals has been studied, notably peas. Disinfection of early sown peas has resulted in increased yields, but no benefit has resulted from the disinfection of late sown. It is thought that the treatment of seeds other than cereals offers a wide scope for investigation, and it is hoped to develop it.

Fire in tulips.—Field and laboratory work has been continued. Experiments are in progress on the disinfection of bulbs.

Asparagus rust.—The American varieties Mary and Martha Washington have been grown for two years at different centres in the area. Although resistant in the United States, reports indicate that they are susceptible when grown in East Anglia; but the degree of susceptibility has not been determined.

Sugar beet diseases.—The area has been again surveyed. The "blackleg" condition was associated with the fungus *Phoma betae,* and "stringy" root with sour soil conditions. Downy mildew was severe when grown adjacent to or near a crop for seed; the mosaic virus also was more noticeable under these conditions. The yellowing of foliage thought to be of a virus nature was particularly prevalent, and more so than mosaic. Violet root rot was prevalent in some areas and is being perpetuated by too frequent growing of the crop on the same land.

A number of cases of heart and dry rot have been received.

White rust of cress (grown for seed).—Experiments to control this disease by rogueing out the primary infections and by dusting the crop with fungicides were abortive.

Soil disinfection for glasshouse crops.—Steam sterilisation has been compared with sterilisation by chemicals such as cresylic acid and formaldehyde and experiments have been made with very weak solutions of certain organic mercurials. Results are not yet available.

Titles of papers issued during the year.

1. Dillon Weston, W. A. R., and Booer, J. R.: An outline of an investigation on disinfectant dusts containing mercury. *J. Agric. Sci.*, Oct., 1935.
2. Beaumont, A., Dillon Weston, W. A. R., and Wallace, E. R.: Fire in tulips. *Ann. Appl. Biol.*, **23**, 1, 57-88, 1936.
3. Dillon Weston, W. A. R.: The sporulation of *Helminthosporium avenae* and *Alternaria solani* in artificial culture. *Trans. Brit. Mycol. Soc.*, **22**, 2, 112-115, 1936.

78. CARDIFF: UNIVERSITY COLLEGE OF SOUTH WALES

Sainfoin.—Further observations at the experimental plot on the progeny of selected plants propagated both vegetatively and by seed were made. These included some study of response to disease as well as of yield and habit.

Lucerne.—The various lots have been maintained for continued observations.

Grasses and clovers.—Several new lots of ryegrass, cocksfoot, and timothy were sown for comparison of their various strains. The red clovers are in their third season and are becoming thin. The white clovers are also in the third year and are showing striking differences in longevity as well as in habit.

Soya bean.—This season further new strains were under trial but few set seed. Trials with inoculating the seed with two American cultures of root nodule organism have been carried out. A proprietary culture appears to have been more successful.

Grassland.—Studies have been made of the effect of different manures on the botanical composition of meadow and of lawn plots.

Clubroot.—A test has been carried out on the effect of mercuric chloride solution applied at the time of planting out of various brassicae. The 1934 allotment trials with mercuric chloride were completed. County variety trials of swedes have been under observation.

Aster Wilt.—Varieties of Asters obtained from Long Ashton were tried for resistance to *Fusarium* wilt at the College plots and elsewhere. The results are very satisfactory.

Title of paper issued during the year.

1. Rees, J.: Grassland problems and crop diseases. *West. Mail Agric. Sup.*, Feb., 1935.

79. HARPER ADAMS AGRICULTURAL COLLEGE

Club root disease.—The effects of various chemicals applied as dry dressings to infected soil were investigated.

Mercurous chloride applied at the rate of 20 gms. per 14 ft. drill length reduced severe clubbing from 83 per cent. in the control rows to 14 per cent. in the treated rows. Mercuric oxide and a non-poisonous proprietary preparation gave promising but inconclusive results. Two dyestuffs, known to be toxic to bacteria, when applied with hydrated lime as a carrier proved no more effective than the lime used alone.

Preliminary experiments with certain allyl compounds indicated that infection might be appreciably reduced by applying small quantities of allyl isothiocyanate to the soil.

The standard mercuric chloride treatment for club root was tried at some new centres, and again proved very successful.

Viola Rot.—Further experiments establishing the importance of *Myrothecium roridum* as a parasite of violas were conducted.

The investigation of possible control measures for this disease has been started. It has been found that the growth of *M. roridum* in culture can be completely inhibited by malachite green at a concentration of 1 in 30,000.

80. LEEDS UNIVERSITY

Investigations are being continued on the disease of Whiteheads in wheat or " night-ripening " as the disease is locally known. Of the various treatments tested, heavy applications of sulphuric acid to the stubble gave by far the best results. Favourable results were also obtained with extracted rape meal and with a mixture of artificial manures plus common salt.

Many excellent strains of broccoli and cauliflower are grown in the West Riding but the crops are badly reduced by the disease of stem rot due to the fungus *Phoma Lingam.* This is promulgated from year to year by the practice of saving home-grown seed, which carries the fungus within the seed coat. An attempt is being made to clean up one such contaminated stock by hot water treatment of the seed and subsequent spraying of the plants with Bordeaux mixture.

Experiments for the control of Spraing or internal rust spot have also been carried out. These consisted in the application of organic manures like extracted rape meal and molassed beet pulp, which bring about changes in the micro-flora of the soil and may in this way protect the potatoes from the disease.

Further trials on the control of Grey Leaf of oats were carried out, but were ruined by unfavourable weather conditions.

Titles of papers issued during the year.

1. Millard, W. A.: Seed-treatment of oats and barley. *Broad Acres*, **1**, 1, Jan., 1935.
2. ———: Liming for sugar-beet and its effect on the subsequent potato crop. *Ibid.*, **1**, 4, Oct., 1935.
3. ———: Hot water treatment for mint rust. *Ibid.*, **1**, 4, Oct., 1935.
4. ———: " Chocolate spot " disease of beans. *Ibid.*, **1**, 4, Oct., 1935.

81. MANCHESTER UNIVERSITY

Stem canker of brassicae (*Phoma lingam*).—This disease has been shown to be carried in the seed as well as in the soil. The production of clean seed and healthy stock-seed plants has been attempted. Several kinds of seed dressings have been tried out experimentally, and one of these has given quite encouraging results.

Leaf blight of celery (*Septoria apii*).—The production of disease-free seed has been successfully accomplished at one centre. As the result of seed treatment and the protection during growth of the resulting parent plants, stocks of healthy seed are being raised. Periodical examination of the plants and the seed produced by them, has been maintained and, so far, no signs of disease have been detected.

Clubroot of brassicae (*Plasmodiophora brassicae*).—If properly and adequately applied, lime has been found to be the cheapest and best antidote for this destructive disease, but it must be allowed sufficient time to act. Where the latter condition cannot be ensured, particularly in the seed-bed or small garden then the mercuric chloride treatment of the soil can be resorted to with absolute confidence. Replication of experiments with this fungicide, at a number of scattered centres, has proved extremely successful in each case.

Grey leaf of oats.—A crop of oats, sown on land treated the previous year with manganese sulphate, showed a certain amount of this leaf disease. Wheat plants raised alongside also showed similar slight symptoms. Apparently, therefore, a single year's treatment of the soil with manganese sulphate (at the recommended rate of $\frac{1}{2}$ cwt. per acre) is not sufficient to correct the soil deficiency factor responsible.

Coprinus comatus destroying playing-fields.—This particular fungus has appeared in huge, dense masses on recently constructed playing-fields and caused much havoc. Experiments for its control have been laid down at two centres. It will be some time before the beneficial effect of any of these can be reliably determined.

So far, one treatment seems rather promising, and it also happens to be a comparatively cheap and easy one to apply.

82. MIDLAND AGRICULTURAL COLLEGE

Investigations have been confined to diseases of sugar beet.

Tail rot.—A disease, apparently the same as that described on the Continent as " beet tail rot," but not previously noticed in this country, was investigated when it caused serious losses on a farm in Lincolnshire. It affects only the root, mainly the " tail " end, and hence is not apparent before the crop is lifted. The tissue of affected roots is filled with a slime of rod-shaped bacteria: but although these bacilli will attack sterilised beet slices, it has not been possible to infect healthy beet artificially. It seems possible therefore that this is a secondary infection, and that the primary attack may be due to one of the fungi (notably *Fusarium* sp.) which encrust affected roots when left in the open.

Black leg.—Attempts to isolate fungi from specimens of this disease met with little success: in some cases *Pythium* was obtained and in others *Phoma*—but none gave *Aphanomyces.* Black leg was found to occur in a number of plants where the seed had been treated with a mercurial dressing.

Seeds artificially infected with *Phoma Betae* were sown with controls in loose soil, and shortly after emergence of the seedlings both lots were well trodden down to simulate heavy rolling. It was found that before this was done, the infected seedlings showed no signs of attack, but a few days afterwards there were definite indications of black leg. The control seedlings showed no sign of damage.

Strangle disease.—An investigation of the cause of damage has indicated that the plants suffer some injury to the superficial tissues in the seedling stage. As a result, the growth in girth of the injured area is arrested, producing the constriction of the stem characteristic of the disease.

Heart rot.—A study of the symptoms of this disease at different stages has been made. It was noticed that the characteristic symptoms viz. death of the growing point, may be shown by " bolters," where the tips both of the main stem and the lateral shoots are killed.

The loss caused by this disease may be severe, reducing not only the weight of the roots, but also the percentage sugar content.

Mosaic.—A survey has shown this disease to be widespread; but a careful investigation indicates that no loss either in weight of roots or in sugar percentage is occasioned by it.

Downy mildew.—This disease is fairly widespread, but rarely attacks more than a small percentage of plants. Comparing healthy and diseased plants with the same number of leaves, it is found that the healthy plants have heavier roots of higher sugar content. When a collection of diseased plants was compared with the same number of healthy plants taken at random from the same part of the field, it was found that on the average the diseased roots were heavier, although the sugar content and purity of their juices was less. This confirms the general observation that downy mildew tends to attack the largest and most vigorous plants.

Rust.—Fifteen healthy and 15 severely rust-infected plants were lifted, weighed and analysed. There was no significant difference in weight or sugar-content between healthy and diseased plants, though the juices of the latter were less pure.

Non-virus sugar beet yellows.

An effort has been made to sort out these types of yellows.

Yellows due to drought.—Plants recover quickly on the occurrence of rain.

Crackly yellows.—This resembles continental virus yellows: but there is no evidence that the condition is transmissible by inoculation, nor is there any accumulation of starch in the leaves (due to failure of translocation) as in virus yellows. The cause of crackly yellows is still unknown.

Speckled yellows.—This has been regarded as a physiological trouble due to deficiency of available manganese. In a trial on a badly affected field, there was a reduction of symptoms in plants treated with manganese sulphate, but later in the season the symptoms vanished on both treated and untreated plants. There was no evidence that treatment had affected the weight or sugar content of the roots.

Marginal leaf scorch.—This differs greatly from other forms of yellows, and is thought to be due to potash deficiency. Further investigation is needed.

Leaf scorch.—The symptoms of this resemble crackly yellows, and the two troubles may possibly be the same disease. Observations indicate that leaf scorch is due to unsuitable soil conditions, arising especially on light soils in dry seasons.

Titles of papers issued during the year.

1. Stirrup, H. H.: Pests and diseases of the sugar-beet. *Bull. Min. Agric.*, No. 93, April, 1935.
2. ————: Tail rot in sugar-beet. *Farmer and Stockbreeder,* 18th March, 1935.
3. ————: Deficiency diseases of plants. *Derbyshire Farmer,* **15,** 3, 94-97, 1935.
4. ————: The rotation of crops—its relation to sugar-beet diseases. *Sugar-beet Ann.,* 75-79, 1935.

83. NEWCASTLE: ARMSTRONG COLLEGE, DURHAM UNIVERSITY

Cumberland seed potato scheme.—This scheme has had as its object the growing on a commercial scale of virus free potato stocks. The scheme has now been in progress for eight years under scientific supervision, and seed of the highest health standard is now being consistently produced. In conjunction with the scheme, trials of Cumberland seed have been carried out in other parts of the country.

Fusarium spp. on British cereals.—This work has been continued, and further species and forms, some previously known only imperfectly, have been investigated (1).

Diseases of turf.

Corticium disease.—This disease, due to *Corticium fuciforme* has been studied with particular reference to conditions affecting its incidence (2). Bordeaux-malachite green mixture was found to give good results on a small scale, and when applied to an affected bowling-green eradicated the disease.

Dollar spot disease.—This disease, caused by *Rhizoctonia* sp. is well-known in the United States, and has now been found in England. Studies to work out the life-cycle of the fungus are in progress, and also investigations of pathogenicity, symptoms, and treatment.

Coprinus damage to playing fields.—Several cases of serious damage by *Coprinus* to parks, etc. (including damage to hard tennis courts) have been investigated. In every case there was a layer of incompletely rotted refuse under the affected areas. Trials of possible treatments are being carried out on a small scale.

Titles of papers issued during the year.

1. Bennett, F. T.: Fungus diseases of bowling and golf greens. *Agric. Prog.*, **12**, 164-169, 1935.
2. ———: Corticum disease of turf. *J. Bd. Greenkeeping Res.*, **4**, 32-39, 1935.

84. READING UNIVERSITY

Bulb diseases.

Grey bulb rot disease of tulips, etc.—Experiments indicated that crops—potatoes and onions—grown during the summer are not attacked, and confirmed the severity of the disease caused by *Sclerotium Tuliparum* in Darwin tulips and Imperator iris, with decreasing susceptibility of Wedgwood iris, scillas, crocuses, ixias and narcissi—all bulbous crops in the soil during the cooler months of the year. Unsatisfactory results were obtained from an attempt to control the disease in infested soil with the strength and quantity of formaldehyde solution which is sufficient to give complete control of " Shanking " in tulips.

Tulip diseases caused by Pythium and Phytophthora spp.—Investigation has been commenced of a disease of tulips caused by (probably) *Pythium de Baryanum* v. *Pelargonii*, which is giving valuable results of great interest for comparison with those previously obtained in connection with the " Shanking etc." disease caused by *Phytophthora erythroseptica* and *P. cryptogea.*

Fusarium disease of tulip foliage.—This disease has been found to be due to *F. avenaceum*, while the source of infection is almost certainly the straw used to cover the boxes while the bulbs are rooting outdoors, before being taken into heat for forcing.

Penicillium disease of bulbous irises.—*Penicillium* sp.—probably *P. corymbiferum*—has been shown to be a definite cause of appreciable rotting of iris bulbs in storage. The progress of the infection is comparatively rapid at a late stage of storage under cool conditions, if the atmosphere is reasonably humid. The infection affects the subsequent growth of the bulbs most seriously when it chances to occur close to the root plate area. The disease is extremely common in commercial stocks of bulbs used for forcing.

Strawberry diseases.

" Cauliflower " disease in strawberry plants, etc.—It has been shown, apparently for the first time, that " cauliflower disease " in strawberries is due to a living organism. It seems most likely that the actual pathogen is a bacterium, of which similar strains have been isolated recently at the Imperial College from strawberries, chrysanthemums, carnations, *Schizanthus*, and sweet peas.

Root rot fungi.—It has been impossible to obtain any evidence of adverse effect during 14 months on the growth of strawberry runners planted in soil infested with six strains of *Cylindrocarpon radicicola*, nor have *Hainesia lythri*, *Pachybasium candidum*, *Coniothyrium Fuckelii* and *Fusarium orthoceras* interfered with the establishment of runners planted in soil infested with these respective fungi.

No adverse effect on the growth of Emperor and Ornatus narcissi, nor of seedlings of *Lilium regale* was shown when these were grown in soil infested with *Cylindrocarpon radicicola*.

On the other hand, bad growth of strawberry plants in patches in Hampshire has been correlated with impeded drainage in the soil.

85. SEALE-HAYNE AGRICULTURAL COLLEGE

Potato blight.—Detailed observations in relation to the weather were carried out as in previous years. Successful forecasts of outbreaks were made and the correlation with the weather map type established last year was confirmed.

Mangold Black Leg.—Liming and manuring trials were laid down, but no case of the disease was observed.

Finger and toe.—Trials were carried out as for Black Leg in mangolds. The disease was present at one centre, and it was shown that liming reduced the disease but different manurings showed no significant variation.

Hot water treatment of narcissus bulbs.—Observations have been continued on growth, flowering and disease (both in the open and under glass) in relation to the date of treatment. In addition to formalin, iodine, methyl mercury nitrate and methyl mercury chloride have been used in the 1935 experiments.

Hot water treatment of other plants.—Grape hyacinths were successfully treated without injury for 2½ hours in the bulb bath. Potatoes were treated for 20 minutes and for one hour on 26th and 27th March. Sprouting was checked so that the growth was later and the crop smaller than the untreated.

Disinfection of broad bean seed.—An attempt to control Leaf Spot (*Ascochyta Fabae*) met with negative results.

Snapdragon rust.—American varieties proved less susceptible than standard varieties.

Tulip fire.—The experimental work during the year consisted of trials of bulb disinfectants, sprays and spreaders, variety trials for susceptibility, and cross inoculations with related *Botrytis* species which gave negative results.

Foliage diseases of iris and narcissus.—In extensive spray trials, Bordeaux with spreader has given good results.

Narcissus stripe.—Further experiments to attempt to transfer the disease failed. Recovery takes place in some varieties.

Anemone failures.—A large variety trial in the College plots gave no sign of trouble. A distance of planting trial has been laid down and pot inoculations carried out.

Titles of papers issued during the year.

1. Beamont, A., and Staniland, L. N.: Eleventh Annual Report, Department of Plant Pathology. *Seale-Hayne Coll. Pamph.*, **44,** 1935.
2. Beamont, A.: Diseases of narcissi and tulips. *Sci. Hort.*, **3,** 184-191, 1935, and *Reading Univ. Bull.*, **47,** 1935.

86. WYE: SOUTH-EASTERN AGRICULTURAL COLLEGE, LONDON UNIVERSITY

The downy mildew of the hop (*Pseudoperonospora Humuli*).—Investigations into the occurrence of the disease have been continued, and correlations between weather conditions and outbreaks of the disease have been established (5).

Virus diseases of the hop.

(i) *New virus disease of the fuggle.*—Investigations have been continued on this disease, first noticed in 1934.

(ii) " *Fluffy-tip.*"—A diseased condition of the bine which is possibly to be attributed to a virus was in evidence in several gardens in Kent in 1934, and caused considerable anxiety among the growers concerned. Investigations are in progress; through the co-operation of the growers, affected hills have been marked in many of the affected gardens, to determine whether the disease persists or not.

Apple scab.—Spraying experiments have been continued for the ninth year in the College plantation at Wye. Plots of Allington Pippin and Newton Wonder were sprayed respectively with Bordeaux mixture and a vegetable (cotton-seed) oil Bordeaux emulsion. The crop was graded by hand for the amount of scab present (6).

Experiments with fungicides.—Biologically-controlled experiments with the hop powdery mildew (*Sphaerotheca Humuli*) were carried out with chloronaphthol, chloropicrin, malachite green, and other substances.

Mushrooms.—Studies have been made of the white and brown plaster moulds (*Oospora fimicola* and *Papulaspora byssina*) which occur in mushroom beds (1) and of *Clitopilus cretatus*, another invader (4).

Research on *Dactylium dendroides* and *Xylaria vaporaria* has been continued. During the year investigational work on many cases of diseases, and on mushroom growing and house constructional problems has been carried out.

Titles of papers issued during the year.

1. Ware, W. M.: Plaster moulds in mushroom beds. *Gard. Chron.*, **96,** 444-445, 463-465, December, 1934.
2. ———: Mushroom growing. *Bull. Min. Agric.*, No. 34, 1935.
3. ———: Mushroom-growing in the United States. *J. Min. Agric.*, **42,** 113-119, May, 1935.
4. ———: *Clitopilus cretatus* as an invader of mushroom beds. *Gard. Chron.*, **97,** 325-326, May, 1935.
5. Salmon, E. S., and Ware, W. M.: The downy mildew of the hop in 1934. *J. S.E. Agric. Coll.*, No. 36, 48-54, July, 1935.
6. ———: " Fluffy-tip " disease of hops. *Ibid.*, No. 37, 22, Jan., 1936.

7. Goodwin, W., Pizer, N. H., Salmon, E. S., and Ware, W. M.: The control of apple scab: Allington Pippin and Newton Wonder, 1934. *Ibid.*, 55-61, July, 1935.
8. Salmon, E. S.: Diseases of hops. *J. Inst. Brewing,* **41,** 235-237, June, 1935.

87. EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE

Hill pasture investigations.—The improvement of the hill pasture treated in 1932 continues. The ground, which was formerly dominated by *Nardus,* was disc-harrowed to break up the matted vegetation, and manures and seeds applied. Yorkshire Fog and wild white clover have established themselves and are spreading. The best results have been obtained with a heavy dressing of basic slag.

In the winter of 1934-35 a further area, dominated by *Nardus* and blaeberry (*Vaccinium myrtillus*), was treated. Various phosphatic manures were applied after disc-harrowing.

In the manurial experiments on *Nardus,* it was found that phosphatic plus nitrogenous manures gave a striking increase in other grasses, particularly *Festuca ovina.*

Pasture manuring experiments.—In co-operation with the Macaulay Institute for Soil Research, a number of trial plots on various kinds of pasture have been laid down. These are to be manured in accordance with the fertility of the soil as measured by laboratory methods. The object is to attempt to correlate pasture improvements as measured biologically, with the results of laboratory soil analyses.

Lawn experiments.—The manurial experiments were continued during the year. A small series of lawn seed mixture plots was laid down.

Control of Equisetum arvense.—A trial of sodium chlorate for the control of the field horsetail (*Equisetum arvense*) was carried out. The weed proved to be fairly resistant to the action of sodium chlorate, and dressings at the rate of less than 3 cwt. per acre were not completely effective in eradication. Two cwt. per acre reduced but did not exterminate the weed, while lighter dressings had little effect.

Titles of papers issued during the year.

1. Heddle, R. G., and Walker, L. M.: Mechanical treatment of rough hill pasture. *Scott. J. Agric.,* **18,** 159-164, 1935.
2. Heddle, R. G.: The management of hill pastures. *Ibid.,* **18,** 148-152, 1935.

88. GLASGOW: WEST OF SCOTLAND AGRICULTURAL COLLEGE

Raan or boron deficiency in swedes.—As stated in the last report, it has been observed that the varieties of swedes particularly susceptible to this disease are those in which fibrous roots are poorly developed: this suggests that the disease is due to some mineral deficiency. Heavy liming is known to reduce the solubility of manganese compounds in soil, and to cause symptoms of manganese deficiency in oats: and heavy liming may increase the incidence of raan. Experiments carried out in 1934 made it quite clear, however, that manganese deficiency was not the cause of the disease.

Water culture experiments indicated that boron was necessary to the growth of swedes and in particular for the formation of branch roots. Field experiments were therefore laid down on severely affected farms, the land being dressed with 20 lb. powdered borax per acre. As a result, treated plots showed among them only one case of slight affection with raan, while untreated plots were heavily attacked (1).

Black rot of swedes.—In this disease the central leaves are curled and distorted; the centre of the shoot and later the bulb rot and turn black, with a strong distinctive smell. It has been found that the primary damage is due to the swede midge, *Contarinia nasturtii.* while the rotting is due to bacteria which enter through the wounds made by the midge.

Leaf stripe of oats (2, 3).—Tests of possible seed disinfectants have been continued and the technique further improved.

Titles of papers issued during the year.

1. O'Brien, D. G., and Dennis, R. W. G.: Raan or boron deficiency in swedes. *Scott. J. Agric.,* **18,** 4, 326-334, 1935.
2. ————: The dry disinfection of oat seed. *Trans. High. and Agric. Soc. of Scotland,* 91-112, 1934.
3. Dennis, R. W. G.: Notes on the occurrence of *Pyrenophora avenae* Ivo. in Scotland. *Trans. Brit. Mycol. Soc.,* **19,** 4, 288-290, 1935.

VETERINARY SCIENCE

89. BANGOR: UNIVERSITY COLLEGE OF NORTH WALES

Further investigation of the efficiency of lamb dysentery serum has been undertaken and there is reason to believe that its occasional failure of the past can be avoided.

Trials of *B. ovitoxicus* serum in the prevention of pulpy kidney disease of young lambs and " strike " of ewes gave no significant results since the death-rate among the control (uninoculated) sheep was very low. A survey of the incidence of the " Braxy-like " diseases of sheep was carried out.

A widespread outbreak of an infectious pneumonia of sheep was under investigation in collaboration with the Institute of Animal Pathology, Cambridge.

A survey of the incidence of tuberculosis in the cattle rearing districts of North Wales has been undertaken. The testing of the 450 cattle over two months old in the first selected district has shown an incidence of 11·8 per cent. infected. The second district is even more typical and, the majority of the cattle having been tested before the close of the year, it is evident that the percentage infected in it is even lower.

Titles of papers issued during the year.

1. Montgomerie, R. F., and Rowlands, W. T.: Pulpy kidney disease of young lambs in North Wales. *Vet. J.*, **90,** 399-403, October, 1934.
2. Montgomerie, R. F.: Tuberculosis in cattle. *J. Roy. San. Inst.*, **55,** 470-481, March, 1935.
3. Green, H. H., Allcroft, W. M., and Montgomerie, R. F.: Hypomagnesmaenia in equine transit tetany. *J. Comp. Path. and Thera.*, **48,** 74-79, March, 1935.
4. Montgomerie, R. F.: " Strike " of sheep in North Wales. *Vet. J.*, **91,** 350-356, August, 1935.

90. BRISTOL UNIVERSITY

The incidence of entero-toxaemia of sheep in the Province.—Information on this subject is being collected by means of a questionnaire. Experimental inoculation of animals on farms where the condition was diagnosed was carried out last spring, and it is hoped that further facilities and material for investigation will be available.

The "Teart" land problem in Somerset.—The previous dry summers have seriously interfered with the work on this disease. Last autumn two animals examined post mortem from "teart" areas which the owners considered were not typical of "teartness" were found to be suffering from Johnë's disease.

"Sway-back" in lambs.—A preliminary investigation into this condition has been undertaken.

Titles of papers issued during the year.

1. Menzies, D. W.: Diseases of young animals, I. Calves. *Worcs. Chron.*, **3**, 1, 49-53, 1934.
2. ————: *Ibid.*, II, Lambs. *Ibid.*, **3**, 2, 96-99, 1935.
3. ————: *Ibid.*, III, Pigs. *Ibid.*, **3**, 3, 169-173, 1935.
4. ————: External parasites of sheep. *Ibid.*, **3**, 4, 226-229, 1935.

91. CAMBRIDGE UNIVERSITY

Lactation tetany of cattle.—It has been previously found that the blood magnesium content of cattle, grazed on farms where this disease occurs, falls during the Spring. Experiments carried out during the period under review indicate that the fall might be due to the pastural conditions which exist on the affected farms at that time of the year. It has also been shown that the magnesium level of the blood can be maintained by feeding a mineral mixture containing magnesium salts.

Fowl paralysis.—Serological tests have been made to determine the possibility of establishing some basis for the diagnosis of the disease during the latest stage. The results of this work have not been encouraging. It has been shown that egg transmission plays an important part in the spread of the disease but attempts to transmit it by inoculation of material obtained from cases of the disease have succeeded in a small percentage of cases only.

Bovine contagious abortion.—The attempt to eradicate this disease by means of the agglutination test and the segregation of affected cattle is being continued on a number of farms. It has been found that in heifers the agglutination test is not always effective for diagnosis.

92. CARDIFF: UNIVERSITY COLLEGE OF SOUTH WALES

Sheep diseases.

"Snuff."—This condition is caused by the maggots of the sheep nostril fly (*Oestrus ovis*): it is characterised by nasal discharge and terminates, often fatally, in pneumonia. It is an extreme form of the "summer pneumonia" previously

described. The larvae may leave the animal within a few minutes of death, and accordingly may not be observed in a post-mortem examination.

Lamb dysentery.—Preliminary reports on the efficacy of serum inoculation against this disease are very promising.

"*Pulpy Kidney.*"—The Institute of Animal Pathology, Cambridge, has supplied material for inoculation, which has given good results.

Swayback.—The Institute has also been investigating an exaggerated form of "swayback" which has appeared in Breconshire.

Other diseases.

Fowl paralysis.—In contrast to the previous year's results, this disease was in every outbreak associated with coccidial infection.

"*Delirium*" *in calves.*—Investigation of this condition, found in a number of calves born in a restricted area, has been continued. Attempts to cure it on the assumption that the disease is due to mineral deficiency have been unsuccessful, although injections of magnesium slightly prolonged the life of the affected calves. It is now thought possible that the problem is genetical.

Titles of papers issued during the year.

1. Bisset, N.: Fowl cholera. *Brecon and Radnor Agric. Gaz.*, **2**, 1, 27-29, 1935.
2. ————: Coccidiosis. *Ibid.*, **2**, 1, 19, 1935.
3. ————: Parasitic gastritis in sheep in South Wales. *Farmer and Stockbreeder*, **49**, 2066, 1935.

93. HARPER ADAMS AGRICULTURAL COLLEGE

Contagious bovine abortion.—Attempts are being made to control contagious abortion of cattle upon a number of farms by the isolation of healthy from infected animals, and repeated blood testing of the non-infected animals. Veterinary practitioners are co-operating and there has been an increased number of enquiries upon the control of this disease.

Experimental work with a dead vaccine has been continued in co-operation with the veterinary research workers of the Ministry of Agriculture.

Tuberculosis in cattle.—A survey of the incidence of bovine tuberculosis in rearing areas has shown that in self-contained rearing herds, the percentage of tuberculosis was low. The possibility of establishing tubercle-free areas in certain districts is receiving consideration.

Mastitis.—Autogenous lacto-vaccination has been used with good results in this condition. The value of various curative preparations and methods of controlling the chronic streptococcal type of the disease have been tried with encouraging results.

Fowl typhoid.—The seriousness of this disease in certain districts is reported. In some outbreaks vaccination appears to have given decidedly beneficial results.

Fowl cholera.—The origin of two outbreaks of fowl cholera was investigated and the possibility of migratory birds conveying the infection appeared possible from a study of the conditions under which the outbreaks occurred.

Infectious entero-hepatitis (*Blackhead*).—The value of a number of arsenical preparations, with other control methods, has been established. A number of chloride preparations have been included in the experimental work. These experiments are not yet completed but at present the experiments indicate that they are of some value.

Neuro-lymphomatosis (*Fowl paralysis*).—A questionnaire, which has been in use in the Province for some years, has been instrumental in gathering information upon a number of points concerning the disease.

A rapid method of diagnosing the type of cells present in birds affected has been discovered.

Cattle disease.—A serious disease of cattle occurred in the Province which was responsible for the deaths of twelve dairy cows in a herd of about fifty animals.

Eight animals had died before the investigational officer was consulted. Bracken poisoning had been diagnosed previously, but deaths continued to occur a fortnight after the herd had been removed from contact with the bracken. At post-mortem the most constant lesion was profuse haemorrhage into the entire length of the intestines. In some animals pneumonia was present together with multiple small haemorrhages in the heart and serous surfaces of abdominal organs. A bipolar organism was isolated from the blood of one animal which had a temperature of 108° F. at the time the blood sample was taken. Transmission experiments upon rabbits, guinea-pigs and pigeons failed to convey the disease. In previous years the owner had lost several animals under similar circumstances.

Titles of papers issued during the year.

1. Downham, K. D., and Crompton, C.: Observations upon neuritis in fowls (so-called fowl paralysis). *Vet. J.*, **90,** 12, 505-507, 1934.
2. Dowham, K. D.: Nephritis or kidney disease of ducks. *J. Brit. Duck Keep. Assoc.*, 1935.
3. ———: Harper Adams laying trials mortality records. 19*th Ann. Poultry Conf.*, August, 1935.
4. ———: Rabbit diseases. 7*th Rabbit Conf.*, August, 1935.

94. LEEDS UNIVERSITY

Poisoning.—A number of cases of suspected poisoning of stock were investigated. Amongst these were cases of poisoning believed to be due to cotton cake in young cattle, carbon tetrachloride in ewes, and bracken and foxglove in cattle.

Paralysis in gilts.—Cases were investigated on one farm, and were attributed to a vitamin " A " deficiency.

Anaemia and scour in piglets.—Cases due to an iron deficiency were investigated on several farms.

Tremblings or moss illness in lambing ewes.—This disease was further investigated and experimental treatment by injections of calcium gluconate was tried with varying results.

Swayback in lambs.—Cases of this condition were met with and reported to the Institute of Animal Pathology, Cambridge, where the disease is being investigated.

Lamb dysentery.—This disease continues to be very prevalent in the Craven district of Yorkshire, but the use of Lamb Dysentery serum on infected farms has proved very effective as a means of prevention.

Parasitic gastritis.—Many outbreaks of this disease amongst sheep, particularly, but also amongst young cattle, have been investigated. With sheep, treatment with 1 per cent. copper sulphate has generally been very beneficial, but with young cattle it appears to be essential that in addition to this treatment the cattle must be removed from the infected pastures and fed in fold yards.

95. LIVERPOOL UNIVERSITY

Contagious abortion control scheme.—At the commencement of the year ten herds were included in this scheme, but in the course of the year testing in two herds has been discontinued. A new herd has been added as a replacement.

In addition to this number a modified eradication scheme is also being attempted on three other farms.

Farmers who have co-operated from the commencement have expressed their extreme satisfaction at the progress of the scheme generally. Very little interference with general herd routine has been experienced. It is proposed in the near future to include some more herds in the eradication scheme.

Survey of wastage due to disease in the dairy herds of Lancashire.—This survey was finally completed, some 35 herds comprising approximately 1,400 head of stock having been brought under review.

Sterility and bovine mastitis were responsible for the greatest wastage, but tuberculosis and abortion figured very prominently amongst the causes for disposal of animals.

Percentages of actual disease wastage are as follows:—

Sterility 11·5, mastitis 9·2, contagious abortion 8·0, tuberculosis 5·7, pneumonia 2·3, Johne's disease 1·9, arthritis 1·5, and sudden death 0·7.

It must be emphasised that this survey was undertaken purely as an educational step. One of the most significant results of this survey has been the increased amount of work falling into the hands of veterinary practitioners. Abortion control schemes have been instituted.

Mastitis.—Work on a method for the control of streptococcic mastitis has been continued, but not extended. The bromthymol blue test combined with clinical examination followed by appropriate grouping of the herd has been the basis of the scheme.

A certain amount of success has been achieved in controlling infection in badly infected herds. In several cases a number of herd-tests on the basis described has considerably reduced gross infection occurring and the appearance of fresh cases.

96. MIDLAND AGRICULTURAL COLLEGE

B.C.G. vaccination.—This has been undertaken in another heavily infected herd. The only young stock in the herd at the time the initial test was made were ten bulling heifers. All of these passed the test and were vaccinated. The fact that the young stock showed 100 per cent. pass was surprising, since the incidence in the dairy herd, as shown by the test, was about 80 per cent. infected.

An attempt to raise a tubercle free herd from a herd of vaccinated animals has been continued. In this attempt all young animals are being tested at six monthly intervals. Three such tests have been made and no reactor has as yet appeared. At the last test ten animals were tested.

Contagious bovine abortion.—The trial of devitalised vaccine commenced in the year previous, has ended. Of 18 animals treated eight aborted, two calved dead calves, and eight calved normally.

Mastitis.—A means was devised of inflating diseased quarters with germicidal gases. Two gases, formaldehyde and chlorine were tried, but no improvement followed repeated inflations.

Eradication of streptococcal infection with the help of bacteriological examination of the milk is being successfully carried out in one herd.

Alleged loss of chicks due to food.—A feeding experiment was carried out on a sample of a well known chick mash. Two groups of 12 day old chicks were used and the control group were fed on a mash supplied by the Poultry Department at the College. The experiment was carried on for 18 days and all chicks were alive at the end of that time.

The 12 chicks fed on the suspected mash increased from 18 ozs. to 54 ozs., while the control 12 increased from 19 ozs. to 75 ozs.

97. NEWCASTLE: ARMSTRONG COLLEGE, DURHAM UNIVERSITY

Lamb dysentery.—During the year under review a large field experiment was conducted to retest the value of specific prophylaxis against the disease known as lamb dysentery. The experiment extended over 17 affected farms and experimental and control groups of ewes and lambs were set up on each farm. Amongst 4,892 lambs born on farms where the ewes had been vaccinated and the lambs received antiserum at birth, the mortality amounted to 18 lambs or 0·36 per cent. On the same farms 2,367 lambs were born in the " no treatment " group, and the mortality was 169 lambs or 7·14 per cent. There was thus no evidence of the failure of specific protection.

Ticks.—Experiments were also conducted to test the deterrent power of anti-tick dips in the eradication of ticks from infested pastures. This experiment embraced six farms. Dipping was carried out at three-weekly intervals throughout the tick season, and weekly counts of ticks were made among the dipped and undipped groups. Interesting results were obtained which indicated that a new dip possesses certain deterrent properties. This work is being continued.

" *Pining* ".—Investigations have also been pursued into the nature of the disease known as " pining " in sheep. The evidence obtained indicates that this disease is partly caused by the presence of internal parasites. It is also probable that the question of nutrition has an important bearing on the incidence of this disease.

Bovine contagious abortion.—Observations have been continued on the work of eradicating this disease from a number of herds.

98. READING UNIVERSITY

Husk or verminous bronchitis of cattle.—Interesting cases of this disease in adult-stock have come to hand and it appears that the disease in its typical form, i.e., as it affects young stock, can occur in adults. Where such outbreaks have been established and " pasteurellosis " eliminated, it is usually found that such stock have either been imported from a country where the disease does not exist or else have been brought from farms where it does not occur. In consequence they possess no initial immunity.

Mastitis.—A proprietary preparation has been used with beneficial effects in several cases of mastitis. Nevertheless, hygienic measures are equally important in clearing up an outbreak.

Redwater in cattle.—This disease persists in Dorset and appears if anything, to be spreading. Owing to its sporadic occurrence and to the fact that frequently only a few cows are affected it is difficult to do more than to continue to collect data relative to each outbreak.

Diseases of pigs.—Paratyphoid infection has been observed to be closely associated with poor hygienic conditions and the suckling of the litters under damp dirty conditions.

Anaemia usually responds to iron treatment and the provision of facilities for outdoor exercise and rooting, but not always so. Data with regard to these instances are accumulating and it is possible that where open-air runs are allowed without additional iron that the soil type has something to do with the continuation of the disease.

Swayback in lambs.—Special importance is attached to this disease of lambs owing to its occurrence in unusual severity in Northamptonshire during the past lambing season. A survey of the disease is in progress.

Abortion in ewes.—Two striking cases of abortion have been met with, 25 and 42 lambs being lost respectively. Despite a thorough enquiry it was not possible to arrive at any conclusion as to the cause.

99. SEALE-HAYNE AGRICULTURAL COLLEGE

Fowl paralysis.—This disease appears to be spreading. A form of it has been observed, and is being studied, in which anorexia is the main symptom: in these cases the nerve trunks to the viscera are affected instead of those to the limbs.

Air-sac mite (*Cytolychus nudus*).—This continues to be found only in association with tuberculosis.

Botulism in poultry.—This condition was determined as the cause of the sudden death of a number of birds: they had had access to a stream polluted by refuse from a cider factory.

Anaerobic (*braxy-like*) *diseases of sheep.*—An enquiry into these diseases and their incidence is being made.

Scour in young pigs.—An experimental vaccine prepared by the Institute of Animal Pathology, Cambridge, did not give encouraging results. Medicinal treatment is now being tried.

Silver fox diseases.—A *Salmonella* organism (? *S. suipestifer*) was found in two cubs which died in an outbreak of disease on one farm. In addition to parasitic worms, it seemed possible that the unthrifty condition of the foxes was partly due to food damaged by forage mites.

100. WYE: SOUTH-EASTERN AGRICULTURAL COLLEGE, LONDON UNIVERSITY

" Struck ".—Field vaccination experiments were repeated and extended in 1934-5, sheep being vaccinated in December and January on 40 farms on Romney Marsh. Returns show that 1·49 per cent. of the number of sheep vaccinated and 3·34 per cent. of the control sheep died of " struck ". The latter figure indicates a low general incidence of the disease, and the extent of the protection given by vaccination was thus not conclusively tested.

Johne's disease.—Experiments are in progress to determine whether the bacteria responsible for this disease in sheep are infective to cattle.

Parasitic gastritis and enteritis.—An adequately controlled field experiment on the treatment of these diseases in sheep, caused by stomach and intestinal worms, has been concluded. This confirmed the results of field experience and of preliminary experiments, that the harmful effects of a heavy worm infestation can be prevented by the regular treatment of sheep with a solution of copper sulphate and nicotine sulphate.

Contagious abortion in cattle.—Work on the control of this disease, and studies on the immunisation of laboratory animals, have been continued.

Titles of papers issued during the year.

1. McEwen, A. D.: The control of parasitic gastritis and enteritis in sheep by treatment with copper sulphate and nicotine sulphate. *J. Comp. Path. and Therap.*, **48**, 218, 1935.
2. ————: Report of Economic Advisory Council's Committee on cattle diseases and repercussions therefrom. *Vet. J.*, **91**, 173, 1935.

AGRICULTURAL AND DAIRY BACTERIOLOGY

101. ABERYSTWYTH: UNIVERSITY COLLEGE OF WALES

The following investigations were continued during the year:—

(i) The bacteriological examination of monthly surprise samples of milk from 12 typical "Designated" Mid-Wales farms.

(ii) Comparison of Wilson modification of the methylene blue test with plate count, coliform test and direct microscopic examination.

Four hundred prelicence and official samples from Accredited producers have been examined during the summer period (May-October). A comparison is now being carried out with a similar number of samples taken during the winter period.

(iii) Influence of storage of milk at 0°-4·5° C. on the colony count and reduction of methylene blue.

(iv) Thermophilic bacteria in raw and pasteurised milk.

(v) Examination of typical mastitis milk by microscopical and plate count methods. Effect of mastitis on plate count and reduction of methylene blue.

(vi) The cause of gassiness in Processed Cheddar Cheese.

Methylene blue test.—Over 4,000 milk samples were examined at three factories, by means of the colony count on standard agar, the coliform test, the methylene blue test at 37° C., and the fermentation test. The tests were compared in pairs, or in all possible combinations.

The results of the investigations show that:—

(*a*) The methylene blue test can be usefully employed for the preliminary grading of milk, particularly during the summer months, and it can serve a useful purpose as a supplementary method of grading in conjunction with the plate count and coliform tests, but it is not advisable to use the test alone as a basis for bonus payments for good quality milk, or for purposes of control or advisory work.

(*b*) The methylene blue test is not a reliable indication of the hygienic quality of milk which contains large numbers of coliform bacteria.

(*c*) A comparison of the fermentation test with the presumptive coliform test shows that the presence of large numbers of coliform bacteria (+ 1/100 ml.) does not always result in a blown or spongy curd. The fermentation test will not therefore serve as a reliable indication of contamination with excessive numbers of coliform bacteria.

Title of paper issued during the year.

1. Thomas, S. B., and Ralph, D. E.: Grading milk at the factory—a consideration of the value of the Methylene Blue Reductase Test and the Fermentation Test. *Welsh J. Agric.*, **11,** 209-224, 1935.

102. BANGOR: UNIVERSITY COLLEGE OF NORTH WALES

No problems of any special note have been encountered, and such problems as have been investigated have been concerned with high bacterial counts and high coliform content, usually due to inefficient methods of production.

Work is being carried out on the modified methylene blue test as proposed by the Ministry of Health for the examination of " Standard " milk. This test is being carried out in conjunction with the present plate count method and the coliform test. The number of samples examined is not yet sufficient to show whether a definite correlation exists between the reduction time and the bacterial count.

103. BRISTOL UNIVERSITY

An investigation has been made of the efficiency of low-pressure steam sterilisers under farm conditions. The prime reason for the investigation was that, on account of their attractive initial cost, many low-pressure sterilising outfits were being installed on farms under conditions which did not appear to make for efficient and economical operation. More than 20 sterilising outfits have been tested.

104. CAMBRIDGE UNIVERSITY

The work undertaken to determine the causes of fluctuations in bacterial plate-count has been continued with particular reference to the influence of position within the incubator. A statistical analysis of the results obtained shows that no significant differences arise from incubation in various positions on any one shelf or at various heights above the shelf. Inter-shelf differences are, however, significant in a high percentage of experiments. In general, there appears to be a count-gradient from the top shelf to the bottom.

Tainted samples of milk have been investigated and the trouble traced to contamination by *Torula* sp., believed to have resulted from contact of the cows with infected foliage.

Preliminary investigation has been made on a number of milk samples displaying abnormality of non-bacterial origin. Enquirers have been referred to the Veterinary Adviser.

Titles of papers issued during the year.

1. Oxley, C. D.: Notes on bacteriological testing of milk samples. *Herts. Milk Rec. Soc. Yr. Bk.*, 1934.
2. ————: Seasonal variation of the percentage butterfat content of milk. *J. Dairy Res.*, **6**, 1, 1935.
3. ————: A study of progress of lactation in relation to the milk yield and the butterfat percentage of milk produced by cows of Shorthorn type. *Ibid.*, **6**, 2, 1935.

105. LEEDS UNIVERSITY

Investigational work on the purity of farm water supplies has demonstrated that the majority of the spring and well supplies of water on farms are unsuitable for dairy purposes and that in many cases the contamination was from surface drainage. There is as yet no cheap and simple method of chlorinating small supplies of water and thus rendering them safe.

The results of the experiments on foul brood disease of bees carried out during the summer of 1935, although not conclusive, are sufficiently encouraging for them to be repeated next year.

Title of paper issued during the year.

1. Chalmers, C. H.: Bacteria in relation to milk supply. *E. Arnold & Co., Lond.*, 1935.

106. MIDLAND AGRICULTURAL COLLEGE

Several cases of unsatisfactory bacteriological results from milk samples, milk taints, ropy milk, gassy curd in cheese-making, and churning difficulties were investigated. A case of tainted milk was found to be due to the feeding of swedes showing second growth in the spring, two to three hours before the afternoon milking. Another taint was traced to the grazing of cows on clover aftermath. A taint in pasteurised milk, alleged to be caused by organisms of the *Clostridium welchii* group, was not substantiated. Contamination of milk with coliform organisms on a Grade A producing farm, was traced to infection of the cotton wool pads by the person responsible for inserting the pads in the syle before milking. The cotton wool pads were inserted by the man responsible for washing the cows' bags, and he did not wash his hands in between the two operations.

Investigations on a simple chemical test for mastitis, as recommended by several American authorities, are in progress. The treatment of mastitis with proprietary infusions is also receiving attention. The work on the relationship between pin point colonies on plants from raw milk and mastitis is being continued.

The reductase test carried out at 60° F. as an indication of the keeping quality of raw milk has received attention and the proposed new reductase test for Grade A samples is also being investigated.

Title of paper issued during the year.

1. Rowlands, A.: Grade A milk and the Accredited Roll. *Notts. Milk Rec. Soc. Handbook*, 1935.

107. READING UNIVERSITY

Methylene blue test.—Work has been done on the methylene blue test with particular reference to certain recent modifications. Comparisons with the keeping quality test and with plate counts have been made.

Plate count of milk from normal and abnormal udders.—728 samples have been collected from individual cows and tested for plate count on standard milk agar. In some cases the milk was collected and tested on five successive days in an attempt to ascertain the true udder counts from normal and abnormal udders. Lacking a certain and easy test for mastitis it is felt that the plate count of milk collected from the teat with reasonable precautions may be of value in certain cases where diagnosis is uncertain or the infection unsuspected.

Title of paper issued during the year.

1. McClemont, J., Mattick, A. T. R., and Irwin, J. O.: The plate count of milk. *J. Dairy Res.*, **6**, 2, 130-147, May, 1935.

108. SEALE-HAYNE AGRICULTURAL COLLEGE

Rennet.—From samples of commercial rennet that were examined it seems probable that the use of rennet heavily contaminated with types of proteolytic and coliform bacteria may sometimes be the cause of defects in cheese.

Pasteurised milk.—Bacteriological analysis of the samples of pasteurised milk submitted for examination during the year indicates that in many cases much stricter bacteriological control of the pasteurising plants is required.

Water supplies.—From the bacteriological examination of water supplies during the year it appears that the use of contaminated water supplies is frequently the cause of high bacterial count, and coliform contamination of milk samples.

109. WYE: SOUTH-EASTERN AGRICULTURAL COLLEGE, LONDON UNIVERSITY

One stage of the critical investigation into Van Oijen's test has been completed. Statistical treatment of five-fold tests shows that within the range investigated (3,000-30,000 per c.c.) the Van Oijen test and the plate count agree well, and the Van Oijen test is about twice as accurate as the plate count. The colony counting error of both methods has been explored. Other investigational work has included an examination of the effect of different methods of mixing churns; the testing of a new make of insulated container and an investigation of the accuracy of coliform test.

Titles of papers issued during the year.

1. Barkworth, H.: A statistical examination of the inter-relationship and variability of plate count, presumptive coliform test and keeping quality of raw milk. *J. Dairy Res.*, **6**, 26-48, 1935.
2. ————: Effect of coliform organisms on the keeping quality of milk. *Milk Industry*, **15**, 83-89, 1935.
3. ————: The flavour of milk. *Ibid.*, **15**, 47-48, 1935.
4. ————: Water supply for dairy farms. *The Sanitarian*, 328-329, July, 1935.
5. ————: Effect of different methods of mixing milk. *J. S.-E. Agric. Coll.*, **36**, 129-130, 1935.
6. ————: Insulated containers for milk samples sent by post. *Ibid.*, **36**, 131-134, 1935.
7. ————: Increase in recorded plate count of milk samples due to adding 1 per cent. separated milk to the medium. *Proc. Soc. Agric. Bact.*, 1935.
8. ————: Colony counting error in plate count. *Ibid.*, 1935.
9. ————: Counting error in the Van Oijen test. *Ibid.*, 1935.
10. ————: Ten-fold plate counts. *Ibid.*, 1935.
11. ————: The Van Oijen Test. *Ibid.*, 1935.

110. EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE

Microflora of A. I. V. *Silage.*—A mixture of grass and clover was ensiled in a number of barrels, which were opened at intervals during the autumn of 1934, and samples examined in order to determine the changes which take place in the microflora of green fodder after treatment by the A.I.V. process. As a rule, a considerable increase was observed in the microbial content of the fodder after ensiling, and the types of organisms encountered in the silage were distinct from those found in the fresh material. The chromogenic rods which predominated in the green fodder were rapidly replaced, first by organisms resembling streptococci and finally by lactobacilli. All the available evidence indicates that considerable microbiological activity must have taken place in the fodder after the addition of the acid (1).

Disease of cultivated mushrooms.—Infection experiments were carried out with pure cultures of the organisms isolated from the diseased mushrooms referred to in the report for 1933-4. In a few cases appearances were observed which simulated those noted in the original outbreak and from some of these, organisms, which could not be distinguished from those used for inoculation, were recovered. The disease, however, failed to spread in the characteristic manner.

Soft rot of swedes.—A number of specimens were received from East Lothian and from these organisms resembling *B. carotovorus* were recovered. The cause of the primary damage to the plant is being investigated by the Advisory Entomologist.

Spraing of potatoes.—In connection with work being carried out at Boghall, diseased tubers were examined for evidence of the presence of parasitic bacteria. None were found.

Title of paper issued during the year.

1. Cunningham, A., and Smith, A. M.: Studies on A.I.V. silage. *Conf. Agric. Bact.*, Newcastle, 1935.

111. GLASGOW: WEST OF SCOTLAND AGRICULTURAL COLLEGE

MILK PRODUCTION.

Proven sires.—A study has been made (10, 12, 13, 16) of the pedigrees of proven Ayrshire sires (a proven sire is a bull with ten or more daughters which have yielded at least 280 lb. butterfat, or 228 lb. as a heifer, in a lactation not exceeding 52 weeks, and calving again within 15 months of the start of the lactation). It was found that the ability to qualify as a proven sire was strongly inherited, only 18 per cent. of such bulls having no other proven sire in their near male ancestry. The paternal grandsire appears to be of greater importance than the maternal grandsire.

Hoven (2-7, 9).—It has been confirmed that a saponin present in white clover is probably the main cause of hoven in the Province. Soils deficient in lime are most likely to bear a clover containing this compound. The liming of these soils sufficiently to make them at least neutral would be of value in some cases: but insufficient liming may even increase the danger.

There is also some indication that lack of balance between nitrogen, potash and phosphate in the soil may be a contributory cause to the occurrence of hoven.

Succulent feeds.—Silage experiments show that sunflowers make better silage than artichokes, and are improved by the addition of 2 per cent. molasses solution. Bracken silage was unsuccessful.

Trials have shown that 15 cwt. of carrots or 17½ cwt. of mangolds have the same feeding value as one ton of swedes. Results of trials over a number of years indicate that, of the following foodstuffs, a pound of dry matter of any one has the same value: A.I.V. silage, dried beet pulp, swedes, mangolds, carrots and potatoes.

Special feeding.—The feeding of butter fat (butter and cream) to cows produced no significant increase in the fat content of their milk. An attempt to colour milk by feeding ground annatto failed, as the cows refused the concentrates mixed with annatto.

Minerals.—A three-year experiment has been concluded (18). Of two groups of cows, the first received a supplement of steamed bone flour in the first and third winters of the experiment, while the second group received the same supplement in the second winter. It was found that the group receiving the supplement gave less milk and less butter fat than the control: while more cows were removed from the herd in the course of the experiment, from the group which had two winters' supplement, than from the group which had the supplement for one winter.

Pasteurisation.—Trials with calves fed with raw and pasteurised milk have been completed (17). Results show that the calves fed on raw milk consistently did better than those on pasteurised. Heifer calves put on milk at five days of age all reacted to the tuberculin test, while only one animal in the other groups reacted.

By varying the length of time during which calves received colostrum it was shown that those receiving it for ten days were less subject to scouring and other calf troubles than those receiving it for only five days.

MILK UTILISATION.

Mastitis.—In the course of examination of large numbers of milk samples by various methods, it was found that in a majority of cases there was a close correlation between the smell and taste of the milk and the incidence of mastitis.

A type of mastitis termed " udder clap ", which caused serious losses to farmers in North Lanarkshire, was investigated. The disease attacks dry cows and in-calf heifers at summer pasture, making them useless as milk producers. The exudate from infected udders contains a non-haemolytic streptococcus and a staphlyococcus, and the disease appears to be fly-borne.

Market milk investigations.—A study was made of the alcohol test, which has been approved by the Scottish Milk Marketing Board as a basis for differentiation in the price of milk. It was found that the test bears no relation to the presence or absence of mastitis, and that many samples of milk of good quality and excellent keeping qualities reacted positively. Milk produced at the beginning and towards the end of a lactation commonly gave a positive reaction.

The incidence of soft curd-producing milks, which are supposed to be of special value for infant feeding, was studied by the Hill curd test. It was found that the proportion of soft curd milks among the herds tested was less than 10 per cent., and some of these showed signs of a mild mastitis infection. It was readily shown in a mastitis-affected herd that this disease lowers the curd tension.

Cheese defects.—A grey-black discoloration of white cheddar cheeses made on one farm was investigated. It had previously been shown that such discolorations could be produced by heavy metal (usually lead or iron) contamination. It was shown that in this case there was no such contamination, and the colour defect was reproduced experimentally by the action of a protein-splitting putrefactive bacillus obtained from the discoloured cheese.

Several cases of taint in cheddar cheeses have been traced to the use of impure commercial rennets.

Experiments with mastitis-infected milk show that attempts to make cheese with it resulted in an extremely weak and soft curd. Similarly the presence of milk from a few infected cows in a bulk sample results in slow working and in the production of weak-bodied cheese.

Cheese manufacture.—When cheddar cheese is made with pure cultures of lactobacilli, it has been found necessary to ripen the cheese milk at 102°-104° F. for about 1¼ hours, subsequently cooling to 86° before renneting. An experiment was made to determine whether this heating and cooling could be dispensed with by using 3 per cent. of starter instead of the usual 1 per cent. By this method normally working cheeses were obtained, but when ripe they were found to be somewhat short and brittle in texture.

Feeding and butter quality.—Trials were made of the effect on the butter from the cows concerned of feeding carrots instead of swedes. It was found that the " carrot " butter was sweet and attractive, but the fat was somewhat softer than usual, and the colour was definitely reddish. As a result of the experiment it is suggested that the addition of a few pounds of carrots to the winter ration may improve the flavour of milk and butter.

Titles of papers issued during the year.

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2. ————: Hoven, or Bloat, in dairy cattle. *Scottish Farmer,* **43,** 2197, 276, 1935.
3. ————: Soil acidity and bloat. *Farmer and Stockbreeder,* 11th March, 1935.
4. ————: Some milk production pointers. *J. Yorks. Agric. Soc.*, 92, 11-14, April, 1935.
5. ————: Minerals for cows. *Ayrshire Cattle Soc. J.*, **7,** 2, 70, June, 1935.
6. ————: Proven sires. *Glasgow Herald,* **153,** 156, 17, 1935.
7. ————: Old bulls go west. *Scottish Farmer,* **43,** 2216, 972, 1935.
8. ————: The feeding of dairy cattle. *Conf. County Organisers Rep.*, 43-45, July, 1935.
9. ————: The dairy cow and minerals. *Scottish Farmer,* **63,** 2223, 1935.
10. M'Candlish, A. C., and Struthers, J. P.: A register of proven Ayrshire sires. *Ayr. Cattle Soc. J.*, **7,** 3, 107-118, September, 1935.
11. ————: Living proven sires. *Ibid.*, **7,** 69, June, 1935.
12. M'Candlish, A. C., and Black, A. N.: The relative values of raw and pasteurised milk in calf feeding. *West of Scotland Agric. Coll. Res. Bull.*, 4, September, 1935.
13. Leitch, R. H.: Bacillus acidophilus et son utilisation dans la fabrication de fromage du cheddar. *Le Lait,* **14,** 138, 786-797, 1934.
14. ————: Butter and its characteristics. *Scottish Trader,* **38,** 14-17, 1934.
15. ————: Bovine mastitis: its recognition and control. *W. of Scotland Agric. Coll. 21st Ann. Rep.*, 33-56, 1935.
16. ————: Raw and pasteurised milk. *Scottish Milk Trade J.*, **2,** 7, 14-18 and 8, 14-34, 1935.
17. ————: Selection of milk for pasteurisation. *Ibid.*, **2,** 9, 14-25, 1935.
18. ————: La pasteurisation du lait devant l'hygiéne et les industries du lait:—fromagerie, beurrerie, etc. *IV*^{e} *Cong. Int. Tech. et Chim. des Industries Agric.* Section E, 9, 9, 1-10, Bruxelles, 1935.
19. ————: Defective flavours in milk. *Farmer and Stockbreeder,* **49,** 1617, 1935.
20. ————: Soft curd milk. *Scott. Milk Trade J.*, **2,** 10, 18-29, 1935.

ECONOMICS

112. NATIONAL MILK COSTS INVESTIGATION (ENGLAND AND WALES).

As a result of negotiations between the Milk Marketing Board, the Advisory Economists and the Ministry, a scheme for the investigation of production costs and the economics of milk production was initiated in 1934. The objects of the scheme which, in the first instance, was to run for one year from 1st November 1934, but which has subsequently been extended for another period of two years, were to obtain financial and other economic data about the milk industry in England and Wales. The control of the working of the scheme is vested in the Agricultural Economists Conference comprising representatives of the Advisory Economists, the Oxford Institute and the Ministry.

In the Autumn of 1934 the scheme was initiated and all the provinces enlisted the co-operation of milk-producing farmers in their area. This involved the keeping of detailed records of all transactions in the dairy herd, i.e., purchases, sales and breeding of stock; transactions in the feeding of the herd; all transactions in labour, whether hired or family; all incidental transactions connected with the production of milk and detailed information with regard to the yield of milk and the methods of its disposal.

The grant allocated by the Milk Marketing Board for the purposes of making this investigation has made it possible for something over 600 records to be kept on farms throughout England and Wales. Each of the 11 provinces was thus responsible for obtaining the records of roughly 55 farms.

For the winter period 1934-5, costs were obtained from 615 milk producers. Of this number 489 were wholesale producers, 41 partly wholesale and partly producer retailer, 75 producer retailers, and ten Grade A (T.T.) and Certified. For the summer period, similar cost data to the above were obtained from 635 farms of which 495 were wholesale producers, 49 intermediate, 73 producer retailers and 18 Grade A (T.T.) and Certified. For the annual period 1934-5, cost records were obtained from 631 farms which include 490 wholesale producers, 51 intermediate, 72 producer retailers and 18 Grade A (T.T.) and Certified.

Each Advisory Economist is free to use the records he collects for the purposes of research and advisory work and the Economists have, in fact, sent individual reports to each co-operating farmer. The Agricultural Economics Research Institute, Oxford, is analysing the records collected in all the provinces.

113. ABERYSTWYTH: UNIVERSITY COLLEGE OF WALES

Agricultural depression and revival.—Financial accounts for four different types of farms show that relatively a group described as " cattle and sheep—better land " suffered most severely in 1933-34 and showed least recovery in 1934-35. The " cattle and milk " farms suffered less than any other group throughout the period of depression and made considerable recovery in 1933-34 and again in 1934-35. Of the other two groups, " cattle and sheep—poor land " began to show recovery in 1933-34 while the ' mixed farms " group did not show it until a year later. The general position of all the farms taken together showed considerable improvement during the year. Of 65 accounts completed 53 showed profits while 12 showed losses, as compared with 45 and 17 respectively in the previous year. The aggregate net profits per acre (taking losses into account) amounted to £1 2s. 6d. as compared with 12s. 7d. per acre in 1933-34 (13, 24).

Depression in cattle industry.—The farms with heavy dependence on sales of young cattle bore the heaviest burden of depression. Their position was largely determined by the weakness of the markets for fat cattle and continued unprofitableness of fattening. Investigation showed that prices of store and fat cattle do not move closely together, and margins are subject to wide variations due to psychological and other causes. Estimates indicated that over a ten-year period the quantity of liveweight increase in cattle represented by these margins was nearly 3 cwt. for Shorthorns and just over 2½ for Herefords (9, 24).

Cattle feeding.—A summary investigation of costs of fattening cattle showed cost per head of production and marketing 448 fat cattle at £4 4s. 8d. and profit at £1 1s. 6d. with an average margin of £5 6s. 2d. to cover the feeders' costs and profits. Results for individual farms varied between a loss of nearly 18s. and profit of over 30s. per head.

Poultry.—Financial accounts for poultry enterprises indicated that in 1934 the more profitable enterprises were those specialised either towards egg production or towards table poultry. For flocks showing favourable results, average profits amounted to 3s. 9d. per bird; while average losses amounted to 2s. 3d. On the balance of profits and losses the net result was an average profit of 1s. 6d. per bird (24).

Dairy economics.—The physical and financial economy of butter-making in Wales depends upon the practical use of the separated milk in livestock production, a condition very infrequently attained in factory production. A farmers' co-operative factory, using only about 2½ gallons of milk and with manufacturing cost of only 1·61d. per lb., showed direct loss on prices and costs of butter of 1·1d. per lb., but including the value of separated milk the net result was a profit of 2·19d. per lb. of butter. A farmers' co-operative cheese factory reduced costs of manufacturing from 13·5d. per 10 lbs. in 1933-34 to 7·51d. in 1934-35 (24).

Marketing and regulation of markets.—Study of conditions of demand for different products in a period of general depression indicates some reason for varying degrees of profitableness of farming. The " natural protection " of the market, together with the " conventional necessity " and " necessity " characteristics of demand—leading to inelasticity, made a relatively strong market for liquid milk. Open competition, rising efficiency in production, instability of currencies, reduced prices of milk products, but higher consumption, considerable in the case of butter and smaller in the case of cheese, mitigated effects of these conditions. Changes in the purchasing power of consumers and in their needs and tastes are important factors in the markets for fat stock and meat. The trend of consumers' appreciation and demand is towards the " lighter ", or more delicate, and more expensive varieties (11). The milk trade offered favourable conditions for regulatory control, of which the Marketing Scheme took advantage. The Milk Marketing Scheme has been of special benefit to Wales (2, 12). With more scattered and unitary organisation and with intensive competition of imports in all phases, the meat trade did not offer the same favourable conditions for regulatory control, and in its absence the trade in fat stock, especially that of cattle, has shown less stability than the milk trade (9, 11, 12).

Population and conditions of life.—Changes in agricultural organisation have cumulative effects on the social life. The proportion of agriculturists in the total of occupied persons in England and Wales continues to fall. Recent proportions are 1911, 8·5 per cent.; 1921, 7·5 per cent.; and 1931, 6·4 per cent. Yet while production is increasing this is due largely to increase in production per person engaged in agriculture. Agricultural labour is being " decasualised ", or at least more regularised. The type of labour in agriculture is tending more to that of the occupiers' family, or towards the " peasant " rather than the " proletariat " type. Within the last 20 years the ratio of employees to all farmers has fallen from about 3 : 1 to about 2 : 1, or measuring by employing farmers from about 4 : 1 to 3 : 1 (1, 3, 4).

Titles of papers issued during the year.

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2. ———: The milk marketing scheme. *Agric. Prog.*, **12,** 1935.
3. ———: The sociological background of adult education in rural districts. *Brit. Inst. Adult. Educ.*, London, 1935.
4. ———: The family farm. *Proc. Int. Conf. Agric. Econ.*, Oxford, 1935.
5. ———: Perspectives et chances de la colonisation agricole. *Cahiers du Renouveau*, Paris, **1,** 3, 1935.
6. ———: To save the beef industry from eclipse. *Farmers' Weekly*, 7th December, 1934.
7. ———: The future of egg production. *Oswestry Advert.*, March, 1935.
8. ———: Store breeders versus feeders. *Farmer and Stockbreeder*, 17th June, 1935.
9. ———: Store breeders must have assistance. *Farmers' Weekly*, 27th September, 1935.
10. Ashby, A. W., and Harry, E. Ll.: Memo. on the position of livestock producers in Wales with special reference to store cattle. *Dept. Agric. Econ. U.C.W.*, Aberystwyth, Oct., 1934.
11. Ashby, A. W., and Jones, W. H.: (*a*) Agriculture; (*b*) The milk industry; (*c*) The livestock and meat industry, *Britain in depression*, Pitman, London, 1935.
12. Ashby, A. W., Jones, W. H., and Phillips, J. R. E.: The operation of the marketing schemes in Wales. *J. Roy. Welsh Agric. Soc.*, 1935.
13. Howell, J. P.: Economic depression in Welsh Agriculture. *Welsh J. Agric.*, **11,** 1935.
14. ———: Quantities and value of farm produce consumed in the farm house. *Ibid.*, **11,** 1935.
15. Harry, E. Ll.: Consumption of milk in a distressed area of South Wales. *Ibid.*, **11,** 1935.
16. ———: The importance of the store cattle trade. *Oswestry Advert.*, March, 1935.
17. ———: Can the Boards succeed? *Farmers' Weekly*, 14th June, 1935.
18. ———: Milk in distressed areas. *The Times*, Sept., 1935.
19. Jones, W. H.: A statistical analysis of farm accounts. *J. Farm Econ.*, U.S.A., **16,** 4, Oct., 1934.
20. ———: Prices of farm products: wholesale-retail margins. *Welsh J. Agric.*, **11,** 1935.
21. Smith, J. H.: The production and marketing of market garden produce in the Aberystwyth area. *Ibid.*, **11,** 1935.
22. Ray, S. C.: Economic conditions of peasants in British India. *Proc. Int. Conf. Agric. Econ.*, Oxford, 1935.
23. Reports of Conferences on development of agricultural co-operative business (mimeographed), Oct., 1934, and June, 1935. *Dept. Agric. Econ. U.C.W.*, Aberystwyth.
24. Report on research and advisory work in agricultural economics, 1934-35. *Ibid.*

114. BRISTOL UNIVERSITY

Financial accounts.—Financial accounts from 146 farms are now received, an increase of 11 over 1933-34.

Market garden smallholdings.—A survey, confined mostly to growers of less than ten acres, was made of the social and economic condition of the small market gardeners in the Evesham-Pershore area of Worcestershire.

Milk costings.—Besides participating in the joint scheme, the centre is continuing the work on dairy herd management. Special attention is being paid to methods of feeding in relation to milk yields.

Poultry costings.—The study of the Economics of Poultry Farming has now been completed for the second year and is being continued for the third year. Twenty-three specialised poultry farms of varying sizes and types are co-operating.

Titles of papers issued during the year.

1. Dawe, C. V., and Wragg, S. R.: Profits and losses in poultry farming. *Bristol U.*, Bull. 14, 1-27, Oct., 1935.
2. ———: Tabular statement of farm accounts. *Wilts. Agric. Account. Soc., Rep.*, 29, 1-25, Jan., 1935.
3. ———: Tabular statement of farm accounts in the county of Somerset. Rep., 31, 1-27, Mar., 1935.
4. ———: Observations on the first poultry survey. *Somerset County Egg Laying Trial Rep.*, 63, Nov., 1934.
5. Dawe, C. V., and Hewett, J. L.: Tabular statement of farm accounts in the counties of Gloucester, Hereford and Worcester. Rep. 30, 1-29, Feb., 1935.
6. Ruston, D. F.: Fruit consumption and supplies. *Worcs. Chron.* **3,** 1, 39-42, 15th Nov., 1934.
7. Wragg, S. R.: The effect of price changes upon farm profits. *Ibid.*, **3,** 2, 101-105, Feb., 1935.
8. Blundell, J. E.: Changes in food costs as the yield per cow increases. *Farm Economist,* **50,** 8, 160-162, Oct., 1934.
9. Dawe, C. V.: Management for milk production. *Berks. N.F.U. Y. B.*, 43-47, Jan., 1935.
10. Dawe, C. V., and Blundell, J. E.: That 550-gallon minimum. *Farmer and Stockbreeder,* **49,** 262, 4th Feb., 1935.
11. Wragg, S. R.: The effect of price changes upon farm profits. *Hereford. Quart. J.*, **3,** 1, 21-25, Mar., 1935.

115. CAMBRIDGE UNIVERSITY

Recent changes in farm organisation.—A study of the material collected in the Provincial Survey, and of official annual statistics, suggests that during the years 1931 to 1933 great changes took place both in the type and volume of the agricultural output of the eastern counties (1). The principal trends apparent are, first, an increase in the volume of the gross output, and, secondly, increased efficiency in livestock production and labour organisation. Net incomes rose during the period in spite of a continual decline in the price index of commodities. The quantities of feeding stuffs and fertilisers purchased by farmers increased by approximately one-third and one-fifth respectively.

Economic organisation of smallholdings.—A comparative study of the financial organisation of 200 holdings of 20-50 acres on the one hand and of 100 farms of 300-500 acres on the other emphasises the difference in economic structure of the two groups (18). While the earnings per person employed were higher on the large farms, the smallholdings (*a*) showed a greater resistance to low prices, (*b*) required half as much more capital per acre, (*c*) produced twice the value of produce per acre, (*d*) employed twice as many workers per acre, and (*e*) produced a substantially greater social output per acre.

The labour bill and output on arable farms.—This study covers 1,000 farms for each of the three years 1931-3 (2). In discussing the financial aspects of the farmer's labour bill it is necessary to distinguish between (*a*) wage rates, (*b*) workers' earnings, and (*c*) cost to the employer. The cost to the employer appears to average 11 per cent. more than wage rates, and 3 per cent. more than workers' earnings. The proportion of high pay to ordinary and low pay workers is increasing. During the period 1931-3 the wage paying capacity of arable farms has varied directly with the size of farm. Density of employment is influenced more by size of farm than by proportion of arable land to grass. The value of the gross output per unit of labour is a factor closely associated with profitableness. Both the gross and net output per person increase directly with size of farm, but the increase takes place at a decreasing rate.

The economic advantages of mixed husbandry.—The great majority of farms in the eastern counties produce more than ten commodities and sell more than five (5). The economic advantages of mixed farming are dealt with quantitatively under the headings: (*a*) utilisation of by-products, (*b*) seasonal distribution of labour, and (*c*) seasonal distribution of income and expenditure. In each of these directions the mixed farmer has decided advantages over the specialist.

A comparison of the financial results of owner occupied and tenant farms.—Type of occupation is in itself not related to profitableness, but owner occupation tends to be more widespread in areas which have suffered most in the recent depression, while the age of owner occupiers is appreciably greater than that of tenants (12).

The influence of size of farm on crop yields per acre.—Investigation by means of partial correlation, taking size of farm and area of crop grown as independent variables, fails to show any significant relationship between size of farm and crop yield per acre.

The influence of changes in size of dairy herds on milk yields per cow.—An increase in number of cows per herd tends to depress the average yield per cow in herd, and *vice versa.* But herds in which the number of cows is increasing tend to have higher yields per cow than those which are being reduced in size (15).

Other studies.—The following investigations were continued or concluded during the year:

(*a*) An investigation of the economic and other aspects of land-ownership in Cambridgeshire (17).

(*b*) A study of the changes in organisation of a Suffolk farm from 1877 to 1933 (10).

(*c*) Investigation of the possibility of computing an index of net returns to farmers from official and other published data on physical outputs and inputs, prices and costs (14).

(*d*) Calculation of a cost index for miscellaneous farm expenses (13).

(*e*) An investigation of the economics of dairy herd management and costs of milk production.

Titles of papers issued during the year.

1. Carslaw, R. McG., and Graves, P. E.: Recent changes in the physical output of arable farms. *Econ. J.*, **45,** 106-116, March, 1935.
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3. ————: The farmer's labour bill. *Farm Econ.*, **1,** 10, Apr., 1935.
4. ————: Forecast of the 1935 wheat acreage. *Ibid.*, **1,** 12, Oct., 1935.
5. Carslaw, R. McG.: In defence of mixed husbandry. *J. Roy. Agric. Soc. Eng.*, **96,** 5-22, 1935.
6. ————: The use of accounts in farm management. *Rep. 6th Int. Conf. Sci. Management,* 1935.
7. ————: The milk problem—higher prices or lower costs? *Farmer and Stockbreeder,* 1st Apr., 1935.
8. ————: Profitable farms use more fertilisers. *Ibid.*, 19th Nov., 1934.
9. Carslaw, R. McG., and Jolly, A. L.: Milk production on arable farms. *Ibid.*, 22nd Oct., 1934.
10. Carson, S. H.: Half a century of change on an East Anglian farm. *J. Roy. Agric. Soc. Eng.*, **96,** 45-78, 1935.
11. ————: Changes in the net output of a Suffolk farm. *Farm Econ.*, **1,** 11, July, 1935.
12. Graves, P. E.: A comparison of the financial results of owner-occupied and tenant farms. *Ibid.*, **1,** 12, 246-247, 1935.
13. ————: An index for miscellaneous farm expenses. *J. Min. Agric.*, **42,** 745-749, Nov., 1935.
14. ————: A tentative method for estimating net farm incomes. *Econ. J.*, **45,** 784-789, Dec., 1935.

15. Graves, P. E.: The influence of size of herd on average yield per cow. *Farmer and Stockbreeder,* 25th March, 1935.
16. Jolly, A. L.: Milk producer-retailers' profits. *Farm Econ.,* **1,** 8, Oct., 1934.
17. MacGregor, J. J.: The pattern of estate ownership in Cambridgeshire. *Ibid.,* **1,** 12, Oct., 1935.
18. Menzies-Kitchin, A. W.: Some aspects of small holdings in the agricultural structure. *Econ. J.,* **44,** 657-675, Dec., 1934.
19. Pettit, G. H. N.: Food recording for dairy cows. *Herts. Milk Record. Soc. Yearbook,* 1935; *Cambs. Milk Record. Soc. Yearbook,* 1935; *Essex Farmers' J.,* 1935; *Dairy Diary,* **7.**
20. Interpretation of farm accounts. *Farm Econ. Branch Farmers' Bull.* 1.

116. HARPER ADAMS AGRICULTURAL COLLEGE

Commercial egg production.—This investigation, in which other provinces are co-operating, has been continued and extended. Aspects to which special attention has been given during the year are replacement and rearing costs; mortality and causes of death; effect of seasonal production on profitability; and the incidence of family labour in poultry keeping. It is noteworthy that hired labour is not important in flocks under 800 birds, although the average size of specialist commercial flock is only 900.

Sugar beet.—The costing of sugar beet has been continued, together with a study of the value on the mixed farm of beet tops and other by-products.

Title of paper issued during the year.

1. Dennis, F. S., and Dinsdale, D. H.: Commercial egg farming, 1931-34. Wildings, Shrewsbury, 1935.

117. LEEDS UNIVERSITY

Tithe rent charge.—In connection with the preparation of evidence for the Royal Commission on Tithe Rent Charge, visits were paid to 20 of the more important agricultural estates and to 40 owner-occupiers, chosen so as to give a representative sample from the Province.

Milk costings.—The work previously in progress has been extended in connection with the national joint scheme.

Egg and poultry costs.—A scheme of investigation of egg and poultry production costs has been commenced in co-ordination with several other Provinces. Particular attention is being paid to the part which can be played by poultry on larger farms of normal type, not situated close to centres of consumption, as opposed to the smaller enterprises on heavily-rented holdings near the consuming centres.

Titles of papers issued during the year.

1. Ruston, A. G.: Recent developments in poultry management and the present position of the industry. *J. Yorks. Fed. Poult. Socs.*, **1**, 1, 1935.
2. ———: A comment on the report of the reorganisation commission. *Ibid.*, **1**, 5, 1935.

118. MANCHESTER UNIVERSITY

Management in feeding for milk (1).—This work, which is based on the keeping and study of records with the object of reducing feeding costs, has been continued. Previous results have indicated that costs of production fall into two groups, (*a*) about 9½d. per gallon of milk for food and grazing, and (*b*) about 5½d., depending on the method of management. During the period of study, several farmers have transferred from the higher to the lower cost level, by dint of increasing their expenditure on artificial manures for grazing. The second level is associated with a reasonable expenditure on fertilisers without drastic cultivation of grassland.

A third level of cost, approximately 3d.-4d. per gallon, has been recognised as a result of further work. This seems to depend on keenness of production and on careful management of grass and purchased food: but further investigation is needed.

Beef.—A study is being made of beef production on grass, a method which is being taken up increasingly in West Lancashire. The main basis of feeding is leys of one to three years, with catch crops of grass or clover between harvest and ploughing. Generous dressings of fertilisers, notably slag, are being given and are justifying themselves.

Mutton.—The benefit of large fertiliser dressings is also being felt where ewe flocks are kept on grass for fat lamb production.

Title of paper issued during the year.

1. Orr, J.: Management for milk production. *Bull. No.* 2.

119. MIDLAND AGRICULTURAL COLLEGE

Potato production and consumption.—The survey of potato production and marketing was concluded during the year, and was supplemented by an inquiry into distribution and consumption in Brigg and Nottingham (1).

Area surveys.—A survey of the poor sand land area of Nottinghamshire is in progress. The economic position and farming practice of the area are being recorded descriptively rather than statistically, and the study includes records of sheep folding.

A broad survey of conditions in the Lincolnshire wold is also being carried out.

Cost and financial accounts.—Cost accounts are now being kept for three farms. The financial accounts scheme is being continued, with its twofold value to the farmer whose accounts are kept, and to the province in that many points of general advisory value arise.

Milk costings and herd management.—In conjunction with the joint milk costings scheme enquiry is being continued into the utilisation of grassland for milk production, grazing records being combined with the records under the joint scheme. This is a continuation of previous work (2).

Milk and meat consumption.—Studies were concluded (2).

Titles of papers issued during the year.

1. Makings, S. M.: Final report on the potato production and marketing in the East Midlands, 1932-34, together with a note on retail distribution and consumption. *Survey Study No.* 3, March, 1935.
2. ———: Some aspects of liquid milk consumption. *J. Min. Agric.*, **42**, 425-429, Aug., 1935.

120. NEWCASTLE: ARMSTRONG COLLEGE, DURHAM UNIVERSITY

Poultry management survey.—This work has been continued, records being collected from 39 enterprises, for many of which records are now available over a period of several years. A tendency is now being noted to give increased attention to the production and sale of table poultry.

Small holdings.—An investigation into the economic status of small holdings in the province has been continued during the year.

Titles of papers issued during the year.

1. Dinsdale, D. H.: The place of the poultry industry in the national economy. *Proc. Agric. Econ. Soc.*, **111**, 4.
2. ———: A survey of the poultry industry in the north of England. *Agric. Prog.*, **12**, 152-163, 1935.
3. ———: Some implications of the farmers' demand for a protected market. *Trans. Northumb. Agric. Discuss. Socs.*, **5**, 5-17, 1934-35.
4. Roy, G. T.: Egg marketing in the north of England. *Farm Econ.*, **1**, 9, 188-190, 1935.
5. Dinsdale, D. H., and Dennis, F. S.: Commercial egg farming. Wilding, Shrewsbury, 1935.

121. READING UNIVERSITY

Cost accounts.—The four cost accounts hitherto kept (for one arable-sheep farm, two mixed farms, and one cheese-making farm) have been continued for the ninth successive year. Costing has also been commenced for two further farms, one the new University Farm at Sonning. The other is a 1,250 acre dairy farm, run on the open air system with pigs and poultry as other activities: here an effort is being made to reclaim nearly derelict downland.

Dairy farm financial accounts.—The keeping of accounts on dairy farms in the Blackmore Vale district has been continued, 13 farms continuing to co-operate. In 1934-5 ten farms made profits and three losses: the average profit was £155 per farm or £1 7s. 7d. per acre. When no charge was made for family labour all but one farm showed profits. The average family income (as opposed to farm income) in 1934-5 was £317 per family, whereas it was £183 in 1933-4, £154 in 1932-3, and £63 in 1931-2. The improvement in 1934-5 is ascribed to the increased prices obtained for milk and milk products in that year.

Herd management for milk production.—This enquiry is being carried out in conjunction with the foregoing. The most important result is the confirmation of the conclusion previously reached in other provinces, that grass is economically superior to other foods, costing less than half as much per unit of starch equivalent.

Strawberry growing.—The study of the financial aspect of strawberry growing in Hampshire has not been carried out fully this year, but results have been obtained from a small group of growers.

Survey of small-holdings.—A survey of county council small-holdings, embracing some 200 holdings in Hants and Dorset, has been carried out and analysis of the data commenced.

Titles of papers issued during the year.

1. Thomas, E.: The small farmers' need for organisation. *Rep. Conf. Agric. Co-op. Business,* Aberystwyth, June, 1935.
2. Bisset, G. B., and Villiers, F. H.: *Financial Accounts Studies,* 7, Sept., 1935.

122. SEALE-HAYNE AGRICULTURAL COLLEGE

Financial accounts.—The accounts of 104 farmers for the year 1933-34, covering an area of 22,621 acres, were collected and reported on.

Changes in the practice of sheep farming on the red loams of mid Devon.—This was studied by a survey of some 60 farms in the Exeter district of Devon. Particular attention was paid to the relative advantages of fat lamb production and hogging, but an attempt to weigh up the two methods against each other led into the heart of the whole farming system. The relative importance of roots in the rotation is nowadays less than it was before the war, whereas in the country generally, thanks to an increase in the acreage of potatoes and sugar beet, roots have rather more than held their own in the rotation. The sheep, the root break, and the barley land are inextricably interwoven.

Survey in South Devon.—In the spring of this year the farmers who in 1928 had co-operated in a farm management survey were visited again. The enquiry this time, however, was confined to the following three aspects:—(*a*) Changes in dairying; (*b*) changes in tenancies and rents; (*c*) changes in farm implements and machinery.

Usable records were obtained from 192 farmers.

Scheme for the investigation of production costs and the economics of milk production.—In common with the other advisory centres, a number of farmers were approached to co-operate in the above scheme. Winter costs for 57 were worked out. In addition to the information sent to the Ministry, to the M.M.B. and to Oxford, a very short report was sent to each farmer.

The economics of land settlement.—The centre took part in an inquiry into the question of how far it is practicable to relieve unemployment by means of land settlement. A questionnaire was prepared and used in collecting records from smallholders in several parts of Devon and Cornwall.

Titles of papers issued during the year.

1. Morris, S. T.: Changes in the practice of sheep farming on the red loams of mid Devon. *Seale-Hayne Coll. Pamphlet,* No. 45, July, 1935.
2. ————: Devon's declining root acreage. *Farm Econ.,* **1,** 11, July, 1935.
3. Long, W. H., and Daniel, C.: Financial results on certain Devon and Cornish farms for the years 1932-33 and 1933-34. *Farmers' Report,* Nos. 9 and 10.
4. Long, W. H.: Size of fields in Devon. *Farm. Econ.,* **1,** 11, July, 1935.
5. ————: Man and horse work on Devon and Cornish farms. *J. Bath and West,* **9,** 1934-35.

123. WYE: SOUTH-EASTERN AGRICULTURAL COLLEGE, LONDON UNIVERSITY

The investigation into farming costs of production and financial results which commenced in 1923 has been carried on upon the same lines as in previous years.

The food recording schemes for dairy cows and for pigs have also been continued, and although the former scheme has established itself upon a solid basis the latter is still handicapped by the fact that facilities for weighing pigs are not always available.

The investigation into the economics of canning peas was temporarily dislocated through the closing down of one of the factories.

Titles of papers issued during the year.

1. Wyllie, J.: Investigation into farming costs of production and financial results. Corn growing: Costs of production and financial results, 1924 to 1932. *S.E. Agric. Coll. Rep.*, 20, Oct., 1934.
2. Wyllie, J., and Hewison, N. V.: Financial results on the college farms. Sheep breeding and feeding over four years, 1930-31 to 1933-34. *Ibid.*, 21, May, 1935.
3. Wyllie, J.: Farm management records. *N.F.U. Year Book*, 321-336, 1935.
4. ————: Milk production costs and selling prices. *Brit. Dairy Farmers Assoc.*, **47**, 12-24, 1935.
5. ————: The value of accounts in farm management. *J. Min. Agric.*, **41**, 103-112, May, 1935.
6. ————: Towards a balanced agriculture. *N.F.U. Monthly Rec.*, February, 1935.
7. ————: The restriction of home production. *Ibid.*, April, 1935.
8. ————: This beef problem. *Ibid.*, June, 1935.
9. ————: Should prices be fixed according to costs of production. *Ibid.*, August, 1935.
10. ———— The use of accounts in farm management. *Proc. Sixth Int. Cong. Sci. Management*, 59-61, 1935.

124. ABERDEEN: NORTH OF SCOTLAND COLLEGE OF AGRICULTURE

Financial accounts investigation.—The permanent feature of the research work of the department centres round this phase which is carried out in collaboration with the Economics Departments of the Edinburgh and Glasgow Colleges and the Department of Agriculture for Scotland.

The grouping of the farms was maintained as formerly, and the results for the crop year 1933-4 showed that there was a slight improvement in the financial returns to the farmer. The effect of balanced organisations was again apparent and on the average such management was better remunerated than the group averages would indicate.

Poultry investigation.—The results of this investigation showed that the returns from poultry enterprises in 1934 had, on the average, decreased, as compared with those for the year 1933, largely as a result of the drop in the income from eggs, but this was also affected by the incidence of disease. The results indicated wide variations, but where the management was progressive and disease avoided, fair profits were obtained (1).

The poultry enterprise can be fostered on the general farm and take its place as a productive unit in a balanced organisation with the result that a better financial return may be obtained from the farm as a whole (2).

Cost accounting.—General cost account records were continued and special accounts with regard to the cost of production of milk were started.

Pig investigation.—A number of records referring to the pig enterprise, both from the breeding and feeding aspects, were collected and are being analysed.

Titles of papers issued during the year.

1. Imper, A. D.: Profitableness of poultry enterprises, 1934. *Aberdeen Press and Journal,* 8th May, 1935.
2. ————: Poultry's place in farm economy. *Scott. Nat. Poult. Council Year Book,* 8-11, 1935.

125. EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE

The study of the three groups of farms (the East of Scotland Arable farms, the Boarder Semi-Arable Sheep farms, and the Border High Ground Sheep farms) is being continued. It is intended to circulate combined reports dealing with the two years 1933-4 and 1934-5 on the completion of the accounts for the latter year.

The analysis of the records for the year 1933-4 suggests that the farmers from whose records the reports are compiled have now passed through the worst phase of the agricultural depression.

Although ten Border low ground farms still showed losses in 1933-34 the average result of this group was more than £260 better than in the previous year, and of the ten farms only five had losses of more than 10/- an acre; while the capital depreciation of their breeding ewe flocks, associated with the severe fall in sheep prices since 1931-32, had by this time worked itself out.

In the group of E. Scottish arable and suburban farms a marked improvement in the average result is also apparent, there being an increase of £454 over 1932-33, towards which the wheat deficiency payments made a very useful contribution.

Accounts were completed for ten smallholdings. The comparison which was available for eight holdings for two years showed that the average net profit per holding was substantially the same, though falling slightly from £97 in 1932-33 to £93 in 1933-34.

The investigation into the economics of poultry commenced twelve months ago has been continued. The accounts and methods of management of twelve specialist poultry farmers were studied in 1933-34. The seven larger farms, relying largely on paid labour, showed an average profit of £255 on the year's working, of which £155 was due to a capital increase; while the five smaller farms, worked almost entirely by the holder and his family, showed an average profit of £85. As in the other groups of farms, however, there were men making substantial profits and others suffering serious losses, convincing evidence of the fact that poultry-keeping even by specialists is no longer the gilt-edged security it is commonly supposed to be.

To each farmer co-operating in the Accounts Service was issued a detailed report concerning the result of his own farm, together with a general report summarising the conclusions suggested by analysis of the records of the farm group. General reports were circulated also to all co-operating farmers.

With the financial assistance of the Scottish Milk Marketing Board an investigation into the cost of milk production in the East of Scotland was commenced as from 1st October, 1934, in collaboration with the Advisory Economists serving the areas covered by the other two agricultural colleges at Aberdeen and Glasgow. This inquiry is continuing for a second year, and steps are now being taken to double the number of collaborating farmers.

A Tractor Costs Investigation was commenced on 1st March, 1935; it is hoped that records for fully fifty tractors will be available for the whole year.

Titles of papers issued during the year.

1. Witney, D., Nutt, J. D., and Kay, W. D.: Financial results of 10 East of Scotland smallholdings for 1933-34.
2. Witney, D., Heath, W. E., and Kay, W. D.: Financial results of border semi-arable sheep farms, 1933-34.
3. ———: Smallholders and the milk scheme.
4. ———: Economic aspects of poultry husbandry.
5. Witney, D.: Interim report on investigation into costs of winter milk production.

Circulated Privately

6. ———: The £ s. d. of poultry farming. *N. Brit. Agric.*, 206, 28th Feb., 1935.
7. ———: Egg packing stations and the future. *Factors' Mag.*, **35,** 3, 175-181, May, 1935.

126. GLASGOW: WEST OF SCOTLAND AGRICULTURAL COLLEGE.

The collection of financial accounts has continued to be the main activity. Investigations undertaken included the preparation of poultry farm accounts, milk-costing, and pig enterprise accounts, while the department was responsible for the preparation of the College Farm cost-accounts. An advisory visit was paid to each farm on the completion of the records.

While the accounting investigation is spreading into new areas, there is still scope for a large measure of expansion along every branch of investigation. On account of isolation the hill-sheep group is almost untouched while a permanent set of enterprise costs among low-ground flocks would be useful as an index to returns. A start has been made on the pig-enterprise but the poultry farm group is as yet scattered and an investigation on a larger scale is necessary.

Title of paper issued during the year.

1. Gilchrist, J. A.: Agriculture in the South-West of Scotland, past and present trends. *J. Agric. Econ. Soc.*, **3**, 4, 227-236, 1935.

GRASSLAND

127. ABERYSTWYTH: UNIVERSITY COLLEGE OF WALES (WELSH PLANT BREEDING STATION)

Severn Bottom land improvement.—Experiments are being commenced in conjunction with the Advisory Chemist with a view to improving large areas of unproductive *Agrostis* pastures on the banks of the Severn in Montgomeryshire.

Hill improvement.—Work on the improvement of hill grazing is being continued.

Grass drying.—Observations will be made on the operation of a large farm, nearly one-third of which is rough grazing, where it is proposed to carry out grass drying. Fields will be grazed at intervals between periods of cutting for the drier.

Title of paper issued during the year.

1. Thomas, M. T.: Field trials with pedigree and indigenous strains of grasses. *Welsh J. Agric.*, **11**, 147-157, 1935.

III OTHER INVESTIGATIONS

PLANT BREEDING AND CULTIVATION

128. PLANT BREEDING WORK ON BROCCOLI

SEALE-HAYNE AGRICULTURAL COLLEGE

In addition to recording all the individuals within 378 pedigree substocks and 14 commercial varieties upon the plant breeding ground, 13 stocks were tested in commercial fields upon a total area of about 50 acres. Ten stocks have been grown in isolated areas with the object of obtaining one to five pounds of seed of each stock for larger trials. During 1935 a complete numerical classification of stocks has been developed.

In 1934-35 an early and severe drought handicapped the plants at all centres and the most important trial in West Cornwall failed completely during this drought.

Special attention was given in the 1934-35 trials to hardy January stocks which are particularly required for West Cornwall. Certain substocks appeared to satisfy the requirements of growers; in every case they represented types not found within existing commercial varieties.

At the request of broccoli growers in Devon, attention was also concentrated upon April maturing Roscoff stocks in view of the unreliability of " late " commercial varieties. The mildness of the climate in this month imposes a severe test upon all stocks and induces the premature production of soft heads in all but the most rigorously selected stocks. Certain substocks proved satisfactory.

Self-pollination and the breeding of stocks from a single original parent have again been found unsatisfactory in almost every case, though 5 fairly vigorous selfed stocks have now been obtained. Chlorotic, frost susceptible and extremely lax plants have been recorded in almost every highly inbred stock although absent from the previous generations.

The progress made by intensive inter-pollination within small groups of plants was very marked in 1934-35.

129. PRODUCTION OF SEED POTATOES ON A COMMERCIAL SCALE IN NORTH WALES

BANGOR: UNIVERSITY COLLEGE OF NORTH WALES.

The number of centres engaged in the scheme during 1935 was 48, the majority of which were situated in Anglesey and Caernarvonshire. Inspection of the growing crops showed that at 29 centres less than 1 per cent. of the plants exhibited symptoms of infection with virus disease, and only at eight centres was more than 3 per cent. of disease recorded. At the remaining 11 centres the crops contained just over 1 per cent. of infection. These figures represent a slight increase in the spread of virus diseases during 1935 as compared with other years, a fact which is believed to be due to the exceptional drought conditions of the two previous seasons.

In comparative yield trials with North Wales seed and Special Stock seed from Scotland, the results are all in favour of the latter, but, since no difference in health or vigour could be detected between the two classes of seed, the difference in yield is believed to be due to some other cause; possibly undue sprouting in storage of the Welsh seed in the abnormally mild autumn and winter of 1934-35. A number of other trials and experiments dealing with problems arising directly out of the scheme were also carried out.

130. TRIALS OF HARDY FRUIT FOR COMMERCIAL PURPOSES

Royal Horticultural Society and Ministry of Agriculture.

Five new varieties of apple were accepted for trial in 1934-35: and two varieties of strawberry, one raspberry, and six apples added to the standard collection.

In the 1935 season, the crops of all fruit were wholly or partially destroyed by the severe frosts in May, and in consequence it was impossible to recommend any new varieties for trial at sub-stations. Many varieties made an abnormal growth of new wood in consequence of the absence of fruit, but all but one of these spurred well for next season.

Pollination experiments.—These have been continued to determine the self-sterility or fertility of new varieties. Being carried out under glass, it was possible to obtain results, as under:

Apples: At least partly self-fertile: " Arthur Turner ", " Epicure ", " Advance ", " Ellisons's Orange ", " Lord Lambourne ", " Melba ", " Superb ".

Plums: Self-fertile: " Bountiful ". Fairly self-fertile: " Marjorie's Seedling ". Only partially self-fertile: " Laxtons's Gage ", " Early Laxton ". Self-sterile: " Delicious ".

Sub-stations.—As at Wisley, the crops were largely destroyed by frost. The sub-station at Osgodby has been discontinued.

Titles of papers issued during the year.

1. Rawes, A. N.: Orchard heating experiment at Wisley. *J. Roy. Hort. Soc.*, **60**, 508-509, 1935.
2. ————: Soft fruits for the private garden. *Cherries and soft fruits, varieties and cultivation. Roy. Hort. Soc.*, 1935.
3. ————: Soft fruits: Notes on varieties under trial at Wisley. *Ibid.*, 1935.

131. BASIC SLAG EXPERIMENTS

ROTHAMSTED EXPERIMENTAL STATION.

As in 1933-34 the main object of the work was to assess the value of some new types of medium-soluble slags. At Rothamsted a pot culture experiment on ryegrass was continued for a second season, testing twelve different phosphatic fertilizers in single and double dressings. The results were in very close agreement with the citric solubilities. Mineralogical analyses revealed clear distinctions between the main types of slags. The two medium soluble slags used in the field experiments proved to have quite different constituents. Field experiments were conducted in Scotland in 1934 and 1935 on four types of slag, and the produce and the results were analysed at Rothamsted. By using single and double dressings of slags in each of the 1935 experiments, it was possible to work on the steep initial portions of the yield curve as well as with the usual rates, which give yields near the top flat portion. The low-soluble slags gave very marked crop increases, but the high-soluble slags were always more effective. Two medium-soluble slags differed much more widely than would be indicated by their citric solubilities, and it is clear that if such slags come on to the market in appreciable quantities more field work and new laboratory methods will be needed to discover means for assessing their relative values. Much time was devoted to preparations for a trial in Northumberland on plots with controlled grazing.

132. BREEDING OF OAT VARIETIES RESISTANT TO FRIT FLY

SCHOOL OF RURAL ECONOMY, OXFORD UNIVERSITY.

The routine work of selection from generations F_1 to F_8 was continued, strains from a Summer x Star cross in particular promising to be of economic value.

The inheritance of resistance by the strain denominated 303173, from the cross Spet x Star, received further confirmation and the degree of " purity " was determined by Latin square investigation. It was shown that (i) it possessed a straw of marked resiliency and comparative fineness, (ii) it yielded grain, but not straw, equally with Victory when sown normally and free from much infestation; therefore, exposed to infestation its yield should be greater than that of Victory, (iii) it exserted its panicles several days earlier than Victory, (iv) some selections from it recovered from attack better than did Victory and, lastly, (v) it possessed a greater grain weight than Victory, by 7 per cent., while it did not exceed Victory in husk percentage.

A study of capability of recovery from attack was commenced; a " shelter " experiment indicated that immigrant flies drifted over the crop, rather than made a vigorous search for plants suited to their purpose; the ratio between carbohydrate production and nitrogen content in the plant at the susceptible stage was investigated and a starting point was indicated for the solution of the problem presented by varietal differences in extent of attack.

PLANT DISEASES AND PESTS

133. BACTERIAL DISEASES OF PLANTS

Imperial College of Science and Technology.

Cases of suspected bacterial disease have been submitted for diagnosis by the Pathological Department of the Ministry of Agriculture and Fisheries and other centres.

In several cases this year an organism answering the description of *Bacillus coli* has been isolated from the diseased tissue of the plant. This is a new phenomenon and suggests that a soil-organism of *coli*-form may have attained a certain degree of parthenogenicity for plants. The isolated strains in pure culture proved incapable, however, of initiating disease when inoculated into experimental plants. There is a possible association of *B. coli* with some obscure pathogen, a state of affairs which is not unlikely and must be looked for in future diagnosis.

In addition to these investigations research has been directed to the discovery of the cause of fasciation in sweet peas, an abnormality which has close similarity with " leafy gall " on various host plants and with " cauliflower " strawberry plant. It was observed that a yellow bacillus is associated with proliferation in all these cases. The organisms isolated from the various hosts behave similarly in culture and all produce the same effect on inoculation of sweet pea seedlings.

Title of paper issued during the year.

1. Lacey, M. S.: Studies in bacteriosis 21. An investigation of marsh spot of peas. With a note on the morphological structure by Brian J. Grieve, Ph.D. *Ann. Appl. Biol.*, **21**, 621-640, 1934.

134. STRAWBERRY DISEASE FIELD INVESTIGATIONS

Reading University.

Hot Water Treatment.—This has been continued as a routine measure in all plantings, and has proved generally satisfactory. It has been shown that under commercial conditions treated plants have, over three generations, exhibited increased vigour, runner production, crop and comparative freedom from pests, when compared with untreated plants.

Experiments have been made on the addition of chemicals to the bath, but no results are yet available.

Strawberry weevil (*Anthonomus rubi*).—No commercial control has been secured. High winds at the flowering season hampered the work of dusting, but even where derris dusts were properly applied they gave only a poor control.

Root weevils.—It has been demonstrated beyond dispute that the presence at the roots of strawberry plants of large numbers of larvae of *Otiorrhynchus sulcatus* and other weevils is one cause of unproductivity. Studies of the life histories of these weevils, and of the means of identifying the larvae of each, are in progress. Tests with poison baits for the adults, and arsenical dressings of the soil for the larvae, have so far been inconclusive.

Strawberry eelworm (*Aphelenchoides fragariae*).—The incidence, seasonal abundance, and effects on the plant of this pest are being studied.

Virus diseases.—Observations over several seasons suggest that there are no diagnostic symptoms by which " yellow edge " can be recognised with certainty. The effects of tarsonemid attack, late planting, drought or even nicotine spraying may produce symptoms indistinguishable from those of the virus disease. Thus our knowledge of the importance of true " yellow edge " is rather limited.

The incidence of crinkle is also under observation.

Isolation plot.—A plot of good strawberry land at Wickham (Hants) has been obtained and planted in April, 1935, with 500 clonal yellow edge free runners from East Malling. The plot is isolated from the nearest strawberries by a metalled road and two ten-foot hedges. The runners were hot-water treated before planting, and 150 were later removed as not making satisfactory growth. From the remainder 10,000 runners were removed in the autumn, and 5,000 smaller runners were left to be planted out in Spring, 1936. 15,000 runners are more than enough to plant an acre of land—a remarkable yield.

Although these plants were pest-free when planted, they were rapidly infected with aphides, and in September *Tarsonemus* appeared on many plants. In the autumn the plants were looking unhealthy, and the opinion was expressed that at least 70 per cent. were suffering from " yellow edge." As pointed out above there is some uncertainty attaching to the diagnosis of this disease, and the behaviour of the plants and runners in 1936 will give valuable evidence on this point. The " virus " symptoms are most strikingly shown by plants infested with *Tarsonemus*; this is noteworthy, since the opinion is definitely held that this mite does not carry virus diseases.

Miscellaneous.—A clone of Royal Sovereign free from diseases and pests has been established. Various studies of diseases and pests and of pest-free plants are in progress.

The sudden dying of plants in spring in Hampshire has been investigated in conjunction with the Soil Surveyor. The suspected cause is summer drought followed by waterlogging in winter.

Titles of papers issued during the year.

1. Hodson, W. E. H.: Eelworm menace to the potato crop. *Farmers' Weekly*, **2**, 13, March, 1935.
2. ————: Cabbage root fly. *Ibid.*, **2**, 16, April, 1935.
3. ————: Control of insect pests of bulbs. A survey of recent work. *Sci. Hort.*, **3**, 192-196, 1935.
4. ————: Pest and disease control in glasshouse soils. *Estate Mag.*, **34**, 12, 931-934, 1934.
5. ————: Eelworm under glass. *Fruitgrower*, **79**, 558, Oct., 1934.

135. WART DISEASE OF POTATOES

ROTHAMSTED EXPERIMENTAL STATION.

A hundred and eleven specimens belonging to 54 numbered and five named varieties were received between 7th March and 5th June 1935. On arrival they were examined macro- and microscopically and an initial report on them sent to Ormskirk. New warts were attached to the shoots and the specimens kept in an infection chamber and examined periodically till the beginning of July.

Of these varieties, 12 only showed no infection at any stage, 40 showed summer sporangia only, and seven summer and winter sporangia; but in all the former and five of the latter the infection subsequently disappeared. The remaining two varieties developed typical wart disease. Nearly all varieties, even those showing no sporangia at any stage, exhibited varying amounts of necrosis.

A survey of five years' laboratory testing for susceptibility to wart disease has been made, and certain changes in procedure suggested.

136. BIOCHEMICAL INVESTIGATIONS ON THE ROOT EELWORM DISEASE OF POTATOES

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE
(INSTITUTE OF AGRICULTURAL PARASITOLOGY).

Action of iron compounds.—Tests of the effect of certain iron and other compounds against *Heterodera schachtii* were made, both in pots and in smale-scale field trials. The compounds used were ferric chloride, ferric oxide, ferrous sulphate, 8-hydroxy quinoline and potassium ethyl xanthate. All the treated plots gave healthier plants than the control plots; on those treated with ferric oxide and with potassium ethyl xanthate there were no symtoms of eelworm disease. Ferric oxide gave the best results, with a crop nearly double the control.

Stimulation of the hatching of larvae.—A study has been made of compounds which might possibly simulate the action of potato root excretion in providing hatching of cysts. It was found that many amino-acids show this effect to some extent. As lysine picrate has a very marked effect, controls were set up with picric acid, and it was found that while this is lethal to larvae in 1 per cent solutions, at dilutions of 0·01 per cent. the hatching of cysts is greatly stimulated The same solution stimulated the hatching of cysts of the pea strain of *H. schachtii.*

Urea.—It was found that very small amounts of urea have no effect on eelworm cysts or larvae; but larger amounts added to infected soil are toxic to the cyst contents. Pot experiments prove that a sufficient amount of urea will prevent the formation of new cysts on the roots of potato plants, while at the same time acting as a valuable nitrogenous fertiliser.

Urea is a decomposition product of calcium cyanamide in soil, and cyanamide had already been proved to have a lethal action on *H. schachtii.* Laboratory experiments indicate that the action of urea is in turn due to its decomposition to produce free ammonia.

Field Experiments.—Field experiments are being commenced on heavily-infected soil in Bedfordshire, Lincolnshire and Lancashire, using different forms of ferric oxide, and different dressings of calcium cyanamide.

Study of potato root secretion.—Efforts have been made to isolate the substance responsible for stimulating the hatching of eelworm cysts from the secretion of potato roots. Very small amounts of the active substance could be extracted with cold absolute alcohol. Surface-active solids e.g. active charcoal, hydrated zinc oxide, will carry down the active substance from the solution, but it has not been possible to regenerate the active substance from the precipitate. Other methods of extraction gave a product still largely contaminated with ash (which forms 80 per cent. of the crude solid root secretion). Further efforts on a larger scale are to be made.

Hot water treatment.—Preliminary studies of the thermal deathpoint of *H. schachtii* have been undertaken, with a view to the possible sterilisation of seed potatoes by hot water treatment.

Titles of papers issued during the year.

1. Hurst, R. H., and Triffitt, M. J.: Experiments on the control of "potato-sickness" by the addition of certain chemicals to soil infected with *Heterodera schachtii. J. Helminth.,* **13,** 4, Dec., 1935.

2. Hurst, R. H., and Triffitt, M. J.: Calcium cyanamide and other artificial fertilisers in the treatment of soil infected with *Heterodera schachtii*. *Ibid.*, **13**, 4, Dec., 1935.

3. ————: On the thermal death-point of *Heterodera schachtii*. *Ibid.*, **13**, 4, Dec., 1935.

137. ECOLOGY OF APHIDES INFESTING THE POTATO CROP

BANGOR: UNIVERSITY COLLEGE OF NORTH WALES.

Virus infection of migrating winged aphides.—Confirmation was sought of the result obtained last year (1) that only a very small proportion of migrating winged *Myzus persicae* are infected with virus diseases, even in districts where the spread of such diseases is rapid. The infestation in 1935 was very low, and only 200 specimens were collected; these were fed on healthy half-tubers in groups of five, and the tubers grown. None of the aphides proved to be infected.

A further test was made by planting healthy half-tubers several yards apart in mangold crops on seven separated farms. The crops have been lifted and stored separately, and will be grown to ascertain their health. This will at the same time provide an indication of the possibility of growing healthy seed in isolation in other crops, in districts where the spread of infection is normally rapid. The spread is being compared with that in plots each of 100 healthy plants, grown in isolation in mangolds, and with that in a plot growing among other potatoes.

Aphis population of isolated potato plants.—At two centres advantage was taken of the above experiment with isolated plants to study the extent to which the plants were infested. It was found that on 14th June, when the plants were less than six inches high, over half the plants were infested with *M. persicae*, and a fortnight later 99 per cent. were infested. From this date the percentage fell to 65 per cent. at the end of July and 30 per cent. a month later. At the end of August only 26 per cent. were infested and the density was only 16 aphides per 100 leaves.

These figures were compared with those for plants in the ordinary crop. Percentage infestation on 28th June was about the same, but the number of *M. persicae* was 174 per 100 leaves on the isolated plants, and 294 in the crop. The subsequent decline was much slower in the crop; at the end of July there were still 90 per cent. of plants infested at a density of 210 per 100 leaves as against 31 per 100 leaves on isolated plants.

It appears that the wingless forms breed more successfully within the crop, and the winged forms (alatae) tend to spread. The number of alatae is higher on isolated plants, as they remain on the plants owing to lack of contact with other host plants.

Spraying trials.—As it is indicated that the main spread of virus diseases is by wingless aphides, an experiment was made on spraying potatoes with nicotine to keep these down. The experiment was inconclusive owing to the low infestation, but control was not established.

Insect trap.—A study of the influence of meteorological conditions upon migration has been made, using a water-power mechanical insect trap which can be operated continuously day and night (3).

Factors affecting migration of winged aphides.—The numbers caught were small. It appeared that migration only occurred when high temperatures coincided with light winds from an easterly direction.

In laboratory experiments it was shown that *Myzus persicae* did not fly when the wind in the experimental chamber exceeded 3¾ m.p.h. Individuals were not detached from the walls by winds of 70 m.p.h. (2).

Titles of papers issued during the year.

1. Davies, W. M., and Whitehead, T.: Studies on aphides infesting the potato crop. 4. Notes on migration and condition of alate *Myzus persicae* Sulz. *Ann. Appl. Biol.*, **22,** 3, 549-556, Aug., 1935.
2. Davies, W. M. *Ibid.* 5. Effect of variation of wind velocity upon flight of aphides. *Ibid.* (in the press).
3. ————: A water-power mechanical insect trap. *Bull. Ent. Res.*, **26,** 4, 553-558, Dec., 1935.

138. INVESTIGATIONS ON INSECTICIDES AND FUNGICIDES

(A) Bristol University.

The preliminary work carried out in this, the first year of the investigation has been limited to the establishment of a special fruit plot for spraying trials.

The planting of this plot of 9½ acres has been practically completed, the planted material consisting of apples, plums, blackcurrants, and gooseberries, whilst the remainder of the plot will be utilised for pears, loganberries and raspberries.

The varieties of each kind of fruit have been selected as particularly suited to the study of outstanding spraying problems, e.g. special susceptibility to pests, and liability to spray damage.

An experiment on canker control has been commenced on the young apple trees in which methods of controlling cankers developed through pruning wounds will be studied.

(B) East Malling Research Station.

Experiments at this centre have been directed towards the evolution of a laboratory method of testing the toxicity of fungicides under standardised conditions. The aim of the method is not to imitate exactly natural conditions, but to use conditions in which the factors bearing on fungicide efficiency are simulated, as nearly as possible, in a standard form which can be varied and reproduced at will.

Tests so far have been carried out with Bordeaux mixture and Apple Scab (*Venturia inaequalis*), and the method has been as follows:—

Glass slides chemically cleaned are used in place of leaves and on them Bordeaux mixture of known strength is dropped from a graduated pipette so as to form a liquid film approximately one-tenth m.m. thick; the slides are then air-dried. Scab spores are cultured on agar films or on sterilised apple wood, from which a spore suspension is obtained by washing with distilled water. Suspensions are made from young cultures, so that all the spores are approximately the same age. The suspension is regulated to contain about 80 spores per two m.m. microscopic field, and a known volume per area is put on the slides with spray deposit. Spore suspension is also spread on clean slides as a control. The slides are incubated in moist chambers at constant temperature, and before growth has reached the stage of forming new conidia, the percentage germination is recorded by microscopic examination. It is noted whether spores have germinated or have been inhibited after the start of germination. On control slides 90 per cent. full germination is usually found.

Before adding spores, the slides with spray deposit may be washed for varying periods by being rocked in distilled water, to simulate the action of rain.

The principal object during 1934-35 has been the perfection of the method. Certain results have, however, emerged:—

(i) Bordeaux mixture at very low concentration is toxic to Scab spores: a mixture containing 0·05 per cent. copper sulphate (approximately one-sixteenth the strength used commercially) virtually prevents germination even after an hour's washing.

(ii) Slides bearing an unwashed deposit support distinctly more germination than those washed for a short time.

(iii) The quantity, and possibly also the quality, of the spores liberated in distilled water depends on the age of the culture, and the temperature and humidity conditions under which it was grown. Other factors also may be involved.

(iv) The susceptibility of Scab spores (conidia) to Bordeaux mixture is governed by the presence or absence of nutriment in the suspension.

139. "CHOCOLATE SPOT" IN BEANS

BOTANY SCHOOL, CAMBRIDGE UNIVERSITY.

Previous work had shown that this disease was not due to *Bacillus Lathyri* as had been supposed, but probably to *Botrytis* spp.

Artificial Infection.—The pathogenicity of *Botrytis* spp. was confirmed by greenhouse experiments, in which plants were atomised with a standard spore suspension, and kept in a saturated atmosphere. Every plant showed infection. Some exhibited non-lethal localised lesions resembling the common form of Chocolate Spot disease; others showed lesions which rapidly coalesced, causing blackening and death of a part or the whole of the shoot system. This second form corresponds to the disease as it appears in occasional severe epidemics. In a saturated atmosphere most of the plants showed the severe form of the infection; but if the plants were transferred to a drier atmosphere after initial infection, the milder form of the disease was produced.

It was found almost always impossible to demonstrate histologically fungal hyphae in infected plants, except where the infection had progressed to the lethal type.

Environmental conditions for infection.—Studies in a controlled environment chamber showed that a surface film of moisture is essential for infection. Thus low relative humidity, high temparature, and air movement, which encourage evaporation of the film, will tend to prevent infection. These factors as they affect the surface of the plant will be modified in their action by the density of sowing and height of the plants.

The maximum temperature for infection was found to be 30° C. The minimum has not been determined, but infection would not occur at 5° C.

Field experiments showed that high relative humidity alone was not enough for infection; rain, coupled with a high relative humidity lasting a considerable time, was essential.

Pathogenicity of the fungus.—It was found that *Botrytis* spores remained viable on the leaf surface for over one month at normal relative humidities, and infection could be produced during that time by placing the plant in a saturated atmosphere. Dried spores remain capable of infection when kept for over three months.

Tests with different strains of *Botrytis cinerea* revealed that all the strains tested were pathogenic. Some allied species e.g.

B. tulipae, are pathogenic to beans, while others e.g. *B. allii* and *B. narcissicola,* are not.

Field studies.—1935 was an epidemic year for Chocolate Spot. The chief sources of natural infection are spores formed on fallen leaves. Secondary sources of infection arise when plants weakened from various causes are killed by the fungus. Under certain conditions infection spreading from these foci may rapidly destroy the crop. Any factor weakening the bean plants predisposes the crop to attack: frequent causes of trouble are waterlogging and potash, phosphate, or lime deficiency.

Since *Botrytis* spores are widespread on healthy plants, it seemed likely that epidemics of the disease were related to environmental conditions. A study of rainfall data seemed to indicate a significant correlation, but a final decision cannot yet be given on this.

Title of paper issued during the year.

1. Wilson, A. R.: Relation of *Botrytis* spp. to the Chocolate Spot disease of beans (*Vicia Faba*). *Nature,* **136,** 226, 1935.

140. DAMAGE BY SLUGS TO POTATO CROP

EDINBURGH AND EAST OF SCOTLAND COLLEGE OF AGRICULTURE.

The species of slugs concerned in damage to the potato crop in the Lothians were first identified, and in the absence of information regarding the life-history and habits of these field forms, these were studied. They have been bred in the laboratory and data relating to pairing, fecundity, growth and food and soil preferences have been obtained. A more detailed investigation of the early development and hatching of the egg of *Agriolimax agrestis* has also been carried out. In the field, observations by day and night have been made in order to determine the occurrence and the abundance of different species, and these have been correlated with varying environmental conditions. Seasonal fluctuations in numbers and activity have been recorded, and, as opportunity offered, feeding and breeding habits in nature have been studied.

The extent and nature of the damage by slugs to potato crops throughout the area has been ascertained, and information obtained from growers regarding the past history of the trouble, individual methods of potato cultivation, and remedial measures attempted. In a few selected fields the course of infestation during the season of 1935 was carefully followed, and conditions in each were noted in detail and compared. The correlation of slugs present and damage done with farming methods, types of soil, varieties grown, and other factors is leading to an understanding of the basic causes of attack.

It is too early yet to make any definite pronouncement with regard to control measures to be adopted. Laboratory tests have shown the slug to be most unsuited to control by poison baits. Of contact lethal agents copper sulphate in powdered form or dilute sulphuric acid were by far the most effective and have the additional merit of cheapness and ease of application. Of far greater importance is the time of application, whether as regards season of year, time of day, or weather conditions of the moment. Another possible remedy was suggested by the fact that in the laboratory slugs showed a strong preference for fresh green food even in the presence of potatoes, and this, coupled with the evidence of farmers that fields containing a fair amount of wrack (*Agropyrum repens*) suffer less from slugs than clean ones, led to the sowing of a clean field with rye-grass in late summer. On suitable nights an abundant slug population could be seen feeding on this grass, and the crop to a large extent escaped their attentions.

A more effective control may be achieved by the alteration of soil conditions in such a way as to render them unsuitable for slugs, as they have shown decided preferences for certain soil conditions. In this connection it is noteworthy that an application of nitrates late in the season resulted in a good yield of undamaged potatoes, while the neighbouring field was one of the worst in the area.

U

DAIRYING AND ANIMAL HUSBANDRY

141. "BLUEING" OF CHEESE

National Institute for Research in Dairying,
University of Reading.

Methods of artificial aeration have been applied to Stilton cheese to study the effect on the ripening process.

There was no evidence that enclosing the cheese in cabinets through which an atmosphere rich in oxygen was made to circulate had any beneficial effect. The results were, however, obscured by the fact that the cheese "slipcoated" and failed to ripen normally.

The internal gases of the cheese were analysed, by withdrawing samples through a perforated hollow probe. It was found that in the early stages there is a large production of CO_2 and almost complete exhaustion of oxygen, while in the ripe cheese there is a higher proportion of oxygen, enough to support mould growth.

The progress of ripening and mould formation were also followed by boring the cheese. This appears to be the only practicable method, but there are the dangers both of altering internal conditions and of putrefaction. Preliminary experiments have been made on the investigation of the interior of the cheese by X-ray photography.

Pricking the cheese had a marked influence in ensuring and accelerating the development of the mould, and by means of this practice well-blued cheese of a good flavour was obtained in four months. Chemical analysis of the ripe cheese indicated a normal breakdown of the casein, but suggested that the ratio of higher to lower fatty acids was greater than for the old type of Stilton cheese.

Dusting the cheese with mould spores, with or without pricking, resulted in the commencement of mould growth 2-3 weeks earlier than in an uninoculated cheese. Ripening proceeded on similar lines and at the same rate in inoculated and uninoculated cheeses, and the effect of pricking in the two was the same.

It has become clear that the volatile acids play an important part in the production of flavour. "White Stilton" contains only the lower acids e.g. acetic and propionic, but the ripe blue-veined cheese contains also such higher acids as caprylic and caproic. The amounts of the various acids differ widely in different batches of cheese. A study is being made of methods of estimating the amounts and proportions of the various acids present.

142. CONTROL OF FLIES IN COWSHEDS

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING,
UNIVERSITY OF READING.

Measurement of fly infestation of cows.—The cowshed was kept clear of flies by the use of fly-papers and repeated spraying. The flies were counted on each cow immediately after entering the shed for the afternoon milking. This method gives an approximate indication of numbers only. It was found that some cows attracted more flies than others—fawn and white Guernseys were much less attractive than red or roan Shorthorns, and this was taken into account in selecting experimental and control groups.

Methods of control.

(i) *Brush at the field gate.*—It is supposed that the majority of the flies are bred in the fields and reach the cowshed on the cows. The gate was fitted with a hedge of broom to brush the underside of the cows, with a mat of reeds reaching down to touch the broom. The cows were sent through this on their way to the afternoon milking while control cows were not sent through. It was found that there was no appreciable difference in the numbers of flies taken into the cowshed; the device was unsatisfactory in its operation, and disturbed the cows for subsequent milking.

(ii) *Water spray at cowshed door.*—The experimental cows were sprayed at the doorway with two jets above and two below. This procedure caused a reduction in the number of flies as compared with those on the control cows. The water made the remaining flies less irritating, and the cows were quieter.

(iii) *Home-made fly repellent.*—Tests were commenced with an inexpensive home-made repellent spray, consisting of two pints light machine oil to one pint paraffin. The experiment was upset by heavy rain associated with a drop in temperature, which reduced the fly infestation to a figure which gave no result.

143. SHEEP FEEDING TRIALS

School of Rural Economy, Oxford University.

The nutrition of the fattening teg.

During the past three winters (1932-3 to 1934-5) sheep feeding experiments have been carried out in an attempt to establish a relationship between the total starch equivalent of the food consumed and the live-weight increase of the animal.

It is generally believed that very low rations are uneconomic because too high a proportion of the total food is used up in meeting the maintenance requirement of the animal. On the other hand there is evidence that at very high levels of nutrition the energy expended on maintenance tends to rise, so that too heavy feeding becomes wasteful. There is, however, very little evidence to show what is the most economic level of feeding.

The general plan of the experiments is to feed a basal ration of hay and to add to this a standard concentrate mixture which is fed at different rates for the different lots—e.g., ¾ lb., 1 lb., 1¼ lb. and 1½ lb. per head per day.

The results so far obtained seem to indicate that the standard figure for the maintenance energy requirement of the sheep (9 lb. starch equivalent per 100 lb. live weight per week) is substantially too high. Several lots fed at about this level, or below it, have made substantial live-weight increases. On the other hand the cost of live-weight increase, in terms of " production starch equivalent ", appears to be higher than that given in feeding tables. On the question of the most economical level of feeding, the experiments suggest that the level may be varied within rather wide limits without greatly affecting the cost, in terms of total starch equivalent, of a pound of gain.

144. DISPOSAL OF MILK FACTORY EFFLUENTS

Rothamsted Experimental Station.

During the year 1934-5 the biological work carried out on the purification of waste washing waters from milk product factories has consisted in the isolation of species of yeasts and bacteria, and the study of their activities. The work does not aim at converting products of food values such as whey, butter-milk and skim milk into liquids for discharge into streams. During the first part of the year observations were made on the bacterial flora of tanks containing a mixture of milk and water of about the composition of a factory effluent; these tanks were of three types; completely anaerobic, partially anaerobic and normally aerated. The cultures obtained by plating from these tanks were classified into species by the ordinary routine tests on sugars and gelatine, when duplicates had been eliminated each species was grown upon milk and on a butter agar to test its value in purifying the effluent. An experimental plant at a commercial factory began work in July 1935, and since that date similar observations have been made on the flora of the various parts of the plant.

V

ANIMAL DISEASES AND PEST

145. BOVINE TUBERCULOSIS

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING,
UNIVERSITY OF READING.

The investigation into bovine tuberculosis described in the report for 1933-4 has been continued and grazing experiments on pasture contaminated with cow-dung containing virulent tubercle bacilli have been carried out. Calves, proved to be tubercular, were fed daily in the spring with a whey ration containing virulent tubercle bacilli, when microscopic examination of the dung showed the presence of a number of acid-fast organisms. The calves were turned out on the pasture and allowed to graze for three weeks when all the grass was exhausted. The calves were removed, infected dung raked evenly over the pasture, and the grass allowed to grow. The freshly grown grass was then grazed down by tubercle-free calves, which, after the grass had been exhausted, were removed and kept for seven months. None of these animals at post-mortem showed any sign whatever of tuberculosis.

It was shown by examination of the infected dung that virulent tubercle bacilli survived exposure on the pasture under the conditions of the experiment for one month only. A repetition of this experiment is being carried out, in which the infection of the pasture has been effected by a cow in an advanced stage of tuberculosis, proved to be passing virulent tubercle bacilli in the dung. Owing to the satisfactory rain in spring and early summer, there was a luxuriant growth of grass, after infection of the pasture, which, as in the previous experiment, had been grazed down by tubercle-free calves. It is proposed in this experiment to allow tubercle-free calves to graze all the winter.

Title of paper issued during the year.

1. Maddock, E. C. G.: Further studies on the survival time of the bovine tubercle bacillus in soil, soil and dung, in dung and on grass, with experiments on feeding guinea pigs and calves on grass artificially infected with bovine tubercle bacilli. *J. Hygiene,* **34,** 3, 372-379, Oct., 1934.

146. SHEEP MAGGOT FLY INVESTIGATIONS

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR.

Chemotropism of Lucilia sericata.

(*a*) The attraction for *L. sericata* of putrefying substances, when placed on sheep, is largely due to the presence of indole, skatole and ammonium carbonate. When dilute solutions of these chemicals are placed in the fleece of live sheep, *L. sericata* females are attracted to oviposit.

(*b*) A technique for testing repellents has been devised which is based on this tropism. The method should be especially valuable for selecting likely repellents for further investigation. It may also prove possible to kill blowflies by treating sheep with a mixture of insecticide and attractant.

(*c*) Individual sheep vary considerably in their attractiveness for *L. sericata;* this may be an important factor in their susceptibility to blowfly attack.

Chemistry of fleece.—Determinations of pH, grease and suint (water-soluble matter) have been made on wool samples from different parts of the body. The results do not show significant differences between the shoulder, a frequent site of attack, and other parts of the back. Since breast wool has the largest amount of suint and seldom becomes infested with maggots, a high suint content by itself does not indicate liability to attack.

Larval nutrition.—Feeding tests have shown that the fat-soluble growth factor required by *L. sericata* larvae is cholesterol. Other sterols can replace cholesterol. These larvae do not require fat-soluble vitamins or fatty acids.

Titles of papers issued during the year.

1. Davies, W. M., and Hobson, R. P.: Sheep blow-fly investigations. Part I. The relationship of humidity to blow-fly attack. *Ann. Appl. Biol.*, **22**, 279-293, 1935.
2. Hobson, R. P.: *Ibid.* Part II. Substances which induce *Lucilia sericata* Mg. to oviposit on sheep. *Ibid.*, **22**, 294-300, 1935.
3. ————: Growth of blow-fly larvae on blood and serum. Part II. Growth in association with bacteria. *Biochem. J.*, **29**, 1286-1291, 1935.
4. ————: On a fat-soluble growth factor required by blow-fly larvae. Part I. Distribution and properties. *Ibid.*, **29**, 1292-1296, 1935.
5. ————: *Ibid.*, Part II. Identity of the growth factor with cholesterol. *Ibid.*, **29**, 2023-2026, 1935.

147. CONTAGIOUS BOVINE ABORTION (SCOTLAND)

(A) HANNAH DAIRY RESEARCH INSTITUTE.

The segregation scheme described in the previous report is being continued in collaboration with the Scottish Committee for Research on Contagious Bovine Abortion. Twenty-one herds are now included in the scheme, and very satisfactory progress has been made.

(B) Rowett Research Institute.

Work under a scheme similar to the above was commenced in February 1934, 12 dairy herds being covered at first. Considerable difficulties were encountered and it was eventually decided to replace seven of these by seven breeding herds. The work is being continued on this basis.

Field tests were made of the use of a nucleo-protein antigen solution for an allergic test. Its value was found to be small.

(C) Incidence of Undulant Fever in Man.

Information regarding the incidence of human undulant fever in Scotland is being collected in co-operation with the Department of Health for Scotland (1).

An enquiry into latent *Br. abortus* infection in veterinary students has been continued. It has been found that the incidence of such infection rises from 8 per cent. in the first-year students to 50 per cent. in post graduates. A group of medical students (who presumably had had no contact with affected animals) showed no reactions.

Title of paper issued during the year.

1. Beattie, C. P., Tulloch, W. J., and Smith, J.: Incidence of undulant fever in the human subject in Scotland. *Lancet,* 22nd June, 1935.

148. WORM INFESTATION OF SHEEP INVESTIGATIONS

Rowett Research Institute, Aberdeen.

Survey.—The survey of the different species of worms affecting Scottish sheep was continued and its scope extended to cover the Outer Isles and Shetland.

The influence of minerals on the susceptibility of sheep to parasitic worms.—The examination of the stomach and intestines of ewes and lambs from Garrochoran, Argyllshire, as detailed in the 1933-4 report, revealed no differences in type or number of worms which could be definitely correlated with mineral feeding.

Examination of worm burden of fat lambs.—There is insufficient evidence to show what number of worms are required to cause symptoms of parasitic gastritis in lambs, since the worm burden of healthy sheep is not properly known. To obtain the necessary information, 75 fat lambs from the Duthie Experimental Stock Farm, Rowett Institute, have been utilised, their stomachs being preserved at slaughter for examination. Results to hand show that a lamb may contain up to 3,000 or more worms and still reach butcher fatness when only four months of age. As the individual history, age, and grazings records of these lambs is known, it is expected that certain correlations between various factors such as time of birth, whether reared single or twin, etc., and worm infestation will be revealed.

Effect of salting pasture on worm burden of grazing lambs.—Artificial infestation of lambs with the small stomach worm is known to be difficult or impossible if their food contains salt. Moreover, the salting of pastures is sometimes practised as a preventive against parasitic gastritis in sheep. To investigate the effect of salt, 30 parasite free lambs were divided into two groups and grazed for six weeks on heavily infested pasture. The grazing of one group was treated with 10 cwt. of salt to the acre. The lambs have now been slaughtered and their stomachs preserved, and detailed worm counts will be made.

Title of paper issued during the year.

1. Robertson, D.: The parasitic worms of sheep in Scotland. *12th Inter. Zool. Conf.*, Lisbon, September, 1935.

149. FOWL PARALYSIS INVESTIGATIONS

MOLTENO INSTITUTE FOR RESEARCH IN PARASITOLOGY,
CAMBRIDGE UNIVERSITY.

Occurrence and diagnosis.—During the year 11 birds out of 1,027 post-mortems performed showed evidence of neuro-lymphomatosis. Certain workers have recorded an incidence of 50 per cent.; but they have regarded all birds showing lymphoidal aggregations, in any situation, as affected with neuro-lymphomatosis, although the victims may be active and laying well.

The disease cannot be diagnosed simply by examination of a blood film, as the increased number of lymphocytes is not a conclusive symptom, but must be considered in conjunction with others—nerve leisons, lymphoidal aggregations in the liver, enlarged spleen, and " lymphocytic " bone marrow. The brain lesions which have been recorded in some cases do not seem to be a constant feature of the disease.

Nerve lesions were not observed in fowls which were not suffering from fowl paralysis: but at times paralysed birds were found to show no lesions. In some at least of these cases the paralysis was due to other causes.

Eye-lesions in neuro-lymphomatosis.—The typical eye-lesion in this disease is infiltration of the iris with lymphoidal cells, making the pupil immobile and distorted. Other iris changes may occur in fowl paralysis, but they are paralleled by a distinct ailment, irido-cyclitis; this may occur without any evidence of fowl paralysis.

Genesis of cells infiltrating the nerves.—These cells belong to the lymphoidal group and include monocytes, histiocytes and also possibly fibroblasts. In early inoculated cases, two types of cell can be distinguished, one a larger round cell with compact nucleus and little cytoplasm. It is possible that in infiltrations monocytes develop into histiocytes and fibroblasts, as they are known to do in tissue-culture. Alternatively it is possible that monocytes migrate in from the blood stream, and histiocytes are formed from the tissues as a reaction.

Inoculations.—The survivors of those birds inoculated with minced organs from cases of neuro-lymphomatosis have been killed and examined. Out of 414 originally inoculated only eight developed nerve lesions.

Relation between tumours (lymphomata) and fowl paralysis.—Tumours of a lymphomatous nature are comparatively frequently found in fowls. These represent the great majority of tumours found, and occur most frequently in the ovaries, and next in the bowel. The cells of these tumours are identical with those of fowl paralysis lesions. The occurrence of such tumours is associated with more than half the observed outbreaks of fowl paralysis. This would seem to suggest that neuro-lymphomatosis is due, not to a definitely neurotropic agent, but to a tumour-producing condition, which secondary factors may cause to be localised in the nerves or elsewhere.

It has repeatedly been observed during the year that the lymphomatous tumour is transmissible by inoculation.

Lymphoma and lymphocythaemia.—It has been shown that in mice, lymphoma is related to lymphocythaemia (the condition in which the number of lymphocytes in the circulation is greatly increased). Experiments have therefore been made to determine whether conditions of this type in fowls are related to neuro-lymphomatosis. The diseases so far tested are progressive anaemia (" erythromyelosis ") and " erythroleucosis ". The latter is characterised by a great enlargement of liver and spleen, owing to growth of the reticulo-endothelial system, with alteration of the marrow and an increased number of monocytes. This disease was found to be transmissible by inoculations of liver or spleen: but a few birds survived, having enlarged livers and spleens which were not infective on inoculation. No instances of paralysis due to nerve lesions were found, though in some birds the kidney was infiltrated with lymphoidal cells.

150. FOUL BROOD DISEASES OF BEES INVESTIGATION

Rothamsted Experimental Station

So-called " European foul brood " of bees has been produced experimentally using pure cultures of *Streptococcus apis* and *Bacillus alvei* employing a technique involving passage of the organisms through starved larvae and subsequently feeding these to the bees of healthy nuclei early in the brood rearing season. So far other methods of inoculation (feeding the bacteria direct to the bees or to the larvae (without starvation) of healthy nuclei) have not proved successful as regard initiating disease. The suggestion that " European foul brood " is no single disease but is a mixed bacterial infection of the brood of bees, normally of weak stocks of bees, has been advanced.

American foul brood has been initiated in healthy nuclei with pure cultures of *Bacillus larvae* employing the " starved larva " technique referred to above. This disease, unlike " European foul brood ", is a well-defined single disease and is definitely caused by *Bacillus larvae* alone. A brood " disease " temporarily referred to as " Uncertain " has been studied. This complaint is apparently not infectious from brood to brood as is the case with the above mentioned diseases, and some evidence in favour of the fact that it is due to a defective queen has been obtained, though this conclusion is to be regarded as temporary pending further investigation.

151. SWINE ERYSIPELAS

Institute of Animal Pathology, Cambridge University.

Considerable progress has been made with the study of certain bionomical aspects of *E. rhusiopathiae*. A technique has been devised for the identification of the organism in intestinal and other materials and its presence in the intestine of " carrier " animals, as well as in those showing clinical symptoms of the disease, has been established.

Vaccination.—Earlier experiments designed to test the immunising properties of a killed vaccine in laboratory animals have been confirmed and arrangements have been made to repeat the work on a larger scale.

152. IMMUNISATION WITH B.C.G. VACCINE

Institute of Animal Pathology, Cambridge University.

The fourth series of experiments was commenced during 1935. It is divided into three parts:

(*a*) Ten calves have been vaccinated each with 100 mg. B.C.G. These animals are being kept in isolation and will be revaccinated at six monthly intervals for a period of three years when they will be tested for resistance.

(*b*) Twenty calves vaccinated with B.C.G. and revaccinated at six monthly intervals together with ten controls are being exposed to regular infection by the oral administration of virulent cultures of tubercle bacilli.

(*c*) An experiment similar to (*b*) in which the vaccinated calves (ten) are being isolated for 18 months before exposure to infection.

Titles of papers issued during the year.

1. Buxton, J. B.: Some aspects of the vaccination of cattle against tuberculosis. *J. State Med.*, **42,** 9, 527-533, 1934.
2. ————: The experimental vaccination of calves against tuberculosis with B.C.G. *Proc. 12th Inter. Vet. Cong.*, **2,** 68-85, 1935.
3. ————: The role of B.C.G. in the vaccination of cattle against tuberculosis. *Edinburgh Med. J.*, **15,** 185-189, 1936.
4. Griffith, A. S., Buxton, J. B., and Glover, R. E.: Immunization experiments on calves with B.C.G. *Lancet,* **228,** 451, 1935.

153. INVESTIGATIONS INTO BRAXY-LIKE DISEASES OF SHEEP

INSTITUTE OF ANIMAL PATHOLOGY, CAMBRIDGE UNIVERSITY.

Work has been concentrated on the identification and classification of a series of cultures of *Cl. welchii* obtained from the intestinal contents of 68 suspected cases of pulpy kidney disease and lamb dysentery. From each case an average of six cultures derived from separate colonies was available. In order to confirm the suggested diagnosis it was not necessary to proceed with any particular series once the presence of an organism of the type suspected had been demonstrated, but it was decided to examine every tube in the hope of obtaining some idea as to the probability of isolating significant organisms. The results showed that, in cases where such organisms were identified, it was not uncommon for them to be present in one or more tubes only and for the remainder of the cultures in the series to be those of other types of *Cl. welchii*. This indicated that essential varieties may be overlooked in a routine examination of this kind and that failure to isolate them is not necessarily to be accepted as negative evidence in arriving at a diagnosis.

The types of *Cl. welchii* identified have been classified as "non-toxigenic", Type A, Type "B or C" and Type D. The non-toxigenic strains were discarded, the Type A strains were further examined to ascertain whether a D factor might develop after longer incubation, and an attempt is now in progress to determine the exact nature of the group classified as type " B or C ". Results obtained to date appear to show that the " D " factor in some of these strains is more prominent than was anticipated and that it develops at a relatively early stage.

The importance of type D strains is also emphasised by the fact that on several occasions they were isolated from the intestinal contents of lambs thought to have suffered from lamb dysentery.

The results obtained already indicate that sera used in the prophylaxis of lamb dysentery should be those which are known to possess a high degree of antitoxin of the D type.

154. PROBLEMS CONNECTED WITH TUBERCULIN TESTS

Institute of Animal Pathology, Cambridge University.

A series of normal cattle is being tested with various types of tuberculin (" old " tuberculin, synthetic medium tuberculin, tuberculin protein, etc.), to determine whether any of these products is capable of inducing a non-specific cutaneous sensitivity.

In addition, a second batch of animals has been infected with organisms, closely related to the tubercle bacillus, which have been said to be capable of inducing a sensitivity to tuberculin. They will be tested with tuberculin, johnin, etc., at regular intervals.

Title of paper issued during the year.

1. Buxton, J. B.: Some aspects of the rôle of tuberculin in the control of tuberculosis. *Proc. Roy. Soc. Med.*, **28**, 257-259, 1934.

FOOD PRODUCTS

155. BLACKENING OF POTATOES

Imperial College of Science and Technology.

A study has been made of the blackening of potatoes after cooking. Since the blackening occurs in slices of potato tuber after they have been raised to a temperature of 100° C. it is evidently not an enzyme reaction, for such a treatment would inactivate the enzyme. It is shown, however, that the presence of the thermostable system responsible for blackening after cooking is associated with a greater activity of the thermolabile, enzymatic tyrosinase system present in all tubers. A possible suggestion is that in a " blackening " potato the first stage in the reaction, for which alone the enzyme is required, takes place before cooking, but not in a " non-blackening " potato.

A test has been devised in which the slices, about one mm. thick, are cut transversely across the tuber about one inch from the heel end and immersed in excess methylated spirit for 20 minutes. The commercial (pink-coloured) methylated spirit can be used. Slices so treated show a dark colouration if they are from a potato showing culinary blackening, but remain white if they are from a tuber not colouring dark on cooking.

156. FUNGUS (*BYSSOCHLAMYS FULVA*) INVESTIGATION

Imperial College of Science and Technology in conjunction with the Fruit and Vegetable Preservation Station, Campden.

Further study was made in the laboratory of the factors affecting the heat resistance of the asci of the fungus *Byssochlamys fulva.* A very important factor in the degree of heat resistance was the strain of the fungus employed but other factors, such as the pH of the medium, play a part. The fact was confirmed that the natural infection of the fruit was easily overcome by slight modifications during the process of canning. The density of sugar solution used in the process was found to be a factor of some importance. Although " blowing " of the can is not normally a feature of *Byssochlamys* infection, it can be induced by using a large " headspace " and storing the can at a high temperature for a few days.

The conclusion is drawn that the natural substrate of the fungus is fruit refuse remaining in the orchard. Other fungi with heat resistant features similar to those of *Byssochlamys fulva* have been isolated.

Title of paper issued during the year.

1. Hull, R.: Investigation of the control of spoilage of processed fruits by *Byssochlamys fulva. Ann. Rep. Fruit & Vegetable Pres. Res. Sta., Campden,* 1933-34. 64-73, 1935.

157. INVESTIGATION ON THE USE OF SULPHUR DIOXIDE IN FRUIT PULP AND JAM

BRISTOL UNIVERSITY.

Absorption of sulphur dioxide by fruit pulp.—Although the total SO_2 associated with SO_2 preserved fruit pulp rose to a maximum within two days of addition of the preservative and subsequently fell during a protracted period, the " fixed " SO_2 increased progressively throughout. The process of fermentation appears to " fix " considerable quantities of SO_2 in fruit pulp. Up to 60 per cent. of the total SO_2 added to preserved fruits has been shown to be unaccounted for after extended periods of preservation in hermetically sealed glass vessels.

Distribution of sulphur dioxide in various preserved fruit tissues.—In raspberries and loganberries, the total SO_2 contained in the seeds was more than twice that associated with the other tissues of the fruit. In other fruits the quantities were almost equal. Blackcurrant skins contained 50 per cent. more SO_2 on a unit weight basis than did the fruit considered as a whole. In raspberry and loganberry seeds the percentage of the fixed SO_2 was 3-5 times as much as that in the whole fruit.

Early picked gooseberries showed smaller percentages of SO_2 in the seeds than in the whole fruits, but with more mature fruit the position was reversed.

Methods of adding sulphur dioxide.—No significant differences were found between the effects of SO_2 used as a solution and as potassium metabisulphite, except in the case of blackberries where the latter gave lower results. In general, calcium sulphite gave increased proportions of fixed SO_2 in the pulp, but there was evidence that with some fruit calcium sulphite had a lower " available " SO_2 figure than other forms of SO_2. (Blackberries and blackcurrants were exceptions.)

Fate of sulphur dioxide in fruit pulp and jam.—Series of pulps from three varieties of soft fruits were made into jam at various stages of the boiling process. After the pulp had been boiled for fifteen minutes, in the case of blackcurrants and strawberries, the " fixed " SO_2 constituted 100 per cent. of the total, i.e. all free SO_2 had been removed. 82 per cent. of the total SO_2 remaining in raspberry pulp after a similar period was in the " fixed " state. The SO_2 remaining in the finished jam showed some degree of correlation with the " fixed " SO_2 in the pulp from which the jam was made.

Vacuum boiled jams contained 125 parts per million of total SO_2 (of which 60 per cent. was " fixed ") against the figures of 80 parts per million (65 per cent. " fixed ") for jams boiled at ordinary pressures.

Title of paper issued during the year.

1. Charley, V. L. S.: Preservation of fruit with sulphur dioxide. Effect of hot and cold methods on residual SO_2 content in jam. *Ann. Rep. Long Ashton Res. Sta.*, 255-263, 1934.

158. RIPENING OF MALTING BARLEY

INSTITUTE FOR RESEARCH IN AGRICULTURAL ENGINEERING, OXFORD UNIVERSITY.

During the summer of 1935 the ripening of a crop of barley of malting quality was followed closely by sampling at two or three days' intervals from 10th July to 26th August (harvest) and at longer intervals thereafter. It was found that development could be divided into three phases.

From fertilisation to 10th July there was a process of concentration of food substances in the corns, and rapid development of the embryo. The metabolic rate (measured by CO_2 emission) and concentration of reducing substances were high, and the weight per 1,000 corns of dry matter, nitrogen, and water were increasing rapidly. Viability of corns was very irregular, but none would germinate.

During the period 10-31 July approximately abscission (the cutting off of vascular connection between corn and stem) took place. Water content was at first steady, and later fell rapidly. The rate of metabolism fell, gradually at first and later rapidly. The dry weight rose gradually to its maximum. As regards the chemical processes going on, condensation was dominating hydrolysis. At the end of the period abscission was complete; the corns had a low water content and a maximum dry matter and nitrogen content. Metabolism was practically at a standstill. Germination and viability of the corns was still low but on the increase.

This phase was followed by a period of " after-ripening ", during which germination and viability increased irregularly to final high values (90 per cent. and 92 per cent. respectively). By 23rd August the barley was fully ripe.

Ripening during storage.—Samples put into storage, after air-drying to 13 per cent. water content, were re-tested on 6th September. All samples taken during the third phase had attained full germination capacity, indicating that the attainment of this is independent of furher drying. Samples from this phase kept in air-tight containers since 1934 showed a similar improvement.

Samples taken during the earlier phases and stored also showed improved viability and germination, but these did not reach the high values given by third-phase samples.

Texture.—During August there was little rain until the 23rd, when heavy rain commenced, and continued for three days. Before this the corns were mainly flinty and whitish in colour. When rain began there was a marked increase in water content, and at the same time there was an increase in the number of mealy corns and a decrease in the number of flinty, associated with a change of colour to deep yellow.

Laboratory experiments indicate that the change from flinty to mealy endosperm can be promoted by damping followed by slow drying: but damping beyond 20-30 per cent. water content ruins the crop by causing germination.

As in 1934, cases were reported where final development of germination capacity is delayed.

Some maltsters take no account of flintiness or mealiness in judging samples: others prefer mealy barley. It seems clear that flinty corns which have attained full weight will germinate as well as mealy: but where drought has caused premature abscission the corns will be poor and have immature embryos, and these corns will be flinty.

Some farmers damp flinty barley to about 20 per cent. water content, and dry it slowly, to produce mealiness. Experiments indicate that where drying is at a low temperature this process will improve cut and colour only: but when heat is applied, the barley will germinate more rapidly as a result of the treatment, i.e., the improved appearance will be accompanied by enhanced quality.

X

MISCELLANEOUS

159. FLUCTUATIONS IN NUMBERS AND INCIDENCE OF DISEASE AMONG WILD ANIMALS

Bureau of Animal Population, Oxford University.

The Bureau investigated vole population in various parts of Great Britain, working chiefly on areas belonging to the Forestry Commission but also on certain rough grazings. A census technique for comparing fluctuations from year to year has now been in operation for four years. Voles were abundant in the west of Scotland and a new station was established for field observations in Argyll. Information was obtained about earlier periods of vole abundance, also about current conditions, confirming the existence of a three to four year period in the fluctuation. This has been correlated with a marked weather fluctuation studied by the Scottish Meteorological Office. Measurements were continued in plant quadrats fenced from vole influence, and these show clearly marked changes in the composition of the plant communities. Parasites surveys were also made.

An enquiry into the distribution of the grey squirrel was carried out partly with the aid of the Road Patrols of the Automobile Association. The results have been embodied in a map, which shows continued spread in many parts of the country.

In addition to work on rodents, studies were made on the numbers of moles, and methods of comparing densities.

160. MUSKRAT INVESTIGATIONS

Bureau of Animal Population, Oxford University.

The habits of the muskrat were studied at the various centres of infestation in England and Scotland. It was confirmed that it is mainly vegetarian, eating especially underwater stems and roots. Often floating cut-off plants are left where the animal has been feeding, and this together with the tooth-marks on the cut ends gives a valuable indication of their presence. Another means of detection is by the examination of dung. This normally contains cast hairs swallowed by the animal, and muskrat hairs can easily be identified microscopically if present in dung of doubtful origin.

Only one disease has been found more than once in muskrats, namely, a streptococcal lung disease; but there is no evidence that this had any serious effect on the population. The animal was found to have a normal complement of parasites, none of economic importance.

The muskrat has a breeding season from March till August; two or three litters are produced, usually seven in a litter. The young do not breed until the year after birth.

Burrows always open under water, and run upwards to end blindly near the surface of the ground. The damage to banks caused by these burrows has not been as serious as was feared.

Various methods of trapping were also studied. It has been claimed that certain essential oils act as lures; but a test on water voles (owing to the scarcity of muskrats) did not support this theory.

161. *SPARTINA TOWNSENDII* INVESTIGATIONS

East Anglian Institute of Agriculture, Chelmsford.

The investigations took the form of (1) a general survey of many of the known and potential *Spartina* fields on the south coast of England, (2) experimental planting on low level areas in Essex and (3) seed-testing.

The survey enabled a comparison to be made between the Essex and the South coast. The most striking feature of most of the tidal mud and *Spartina* areas on the south coast was their land-locked nature, the nearness of their level to spring tide high water mark, and their gentle gradient up to that mark.

In Essex, on the contrary, the more open estuarial conditions generally obtaining have produced a greater scouring action of the tides. This in turn has brought the mud-flats to a lower level and has caused a sharp declivity several feet high to appear separating mud-flats from high salting. The level of many of these mud-flats appears to be well below that capable of colonisation by *Spartina*.

It was the case in 1935, therefore, that the conditions in Essex most favourable to the growth of *Spartina* were to be found for the greater part inshore—precisely where the protective value of the plant is most required.

Efforts have been made to ascertain the lowest level colonisable by *Spartina* and the indications are that this level lies between eight and ten feet below spring tide high water mark. Experiments to grow plants at this depth have shown that other inhibitory factors such as winkle attack and turbulence of the water frequently operated at the same time.

In practice, therefore, it seems unlikely that *Spartina* can succeed below an eight-foot depth, especially when winkles are present or/and marked turbulence of the tidal currents.

Evidence has been accumulated to show that the month of August is probably the best season for planting " cuttings ".

A series of seed-tests have confirmed that the seed has a short period of mortality extending to about 15 weeks from the time of gathering.

162. SOIL SURVEY

SCHOOL OF RURAL ECONOMY, OXFORD UNIVERSITY.

A preliminary survey of the soils of the Chalk and its overlying drifts was undertaken for the purpose of determining the natural soil types occurring.

The possibilities of a pedological study of such soil sites with special reference to the modifications brought about by utilisation proved to be disappointing owing to the difficulty in finding genuinely natural sites as a basis for comparison.

An intensive soil survey of a particular area near Stonor was, however, undertaken. This was carried out in conjunction with a party of students to enable them to acquire modern methods of soil description and map making.

In addition the Cotswold survey was extended into the Eastern region of Wychwood Forest so as to include the Rendzinas of the steep escarpment of the Forest Marble and the meadow soils of the Evenlode Valley.

163. SPRAYING MACHINERY INVESTIGATIONS

SOUTH-EASTERN AGRICULTURAL COLLEGE, WYE.

The investigations have been directed towards collecting data on the influence of nozzle design on efficiency of spraying. A technique was devised for studying the patterns exhibited by various spray cones, and the effect produced when the spray traverses a surface as in commercial spraying. In addition the effectiveness of the spray has been gauged by fixing indicator discs of celluloid in various parts of trees to be sprayed, and ascertaining the amount and nature of the spray deposit produced.

The effect of shape and size of nozzle-orifice, pump-pressure, eddy-chamber depth, and distance from the object sprayed have been studied.

It has been found, as would be expected, that the best results are given by nozzles which give a uniform density of spray throughout the cone produced, or by those which give a uniform hollow cone. A great deal depends on the orifice through which the spray finally issues; small irregularities in the shape of this orifice make a great difference to the uniformity of the spray. The diameter of the orifice has no effect on the fineness of the spray droplets; this depends on the form of the eddy-chamber in which the spray is produced, and also on the pressure used—the higher the pressure the finer the atomisation, as well as the greater the output. The latter point is important since it renders a more rapid working possible.

The effect of grouping several nozzles on one spray lance has also been studied. Some arrangements of the nozzles are less satisfactory than a single one, leading to over-spraying of parts of the tree, and under-spraying of others.

Titles of papers issued during the year.

1. Davies, C., and Smyth-Homewood, G. R. B.: Investigations on machinery used in spraying. Part I. Nozzles. *J. S.E. Agric. Coll.*, No. 34, 39-62, July, 1934.
2. Davies, C.: A method to determine the surface area of trees covered by spray fluid and to obtain a permanent record of the degree of fineness of the deposit. *Ibid.*, 252-253, July, 1934.
3. Davies, C., and Smyth-Homewood, G. R. B.: Investigations on machinery used in spraying. Part II. Nozzles. *Ibid.*, No. 35, 62-85, July, 1935.

APPENDIX

LIST OF DIRECTORS OF RESEARCH INSTITUTES, ETC., AND HEADS OF ADVISORY CENTRES.

I. RESEARCH INSTITUTES, ETC.

A. Soils, Plant Nutrition and Plant Physiology.

Sir E. J. Russell, O.B.E., D.Sc., F.R.S.
Rothamsted Experimental Station, Harpenden, Herts.
W. G. Ogg, Esq., M.A., B.Sc., Ph.D.
Macaulay Institute for Soil Research, Craigiebuckler, Aberdeenshire.
R. G. Baskett, Esq., M.Sc., A.I.C.
Chemical and Animal Nutrition Division, Ministry of Agriculture for Northern Ireland, Queen's University, Belfast.
Prof. V. H. Blackman, Sc.D., F.R.S.
Research Institute of Plant Physiology, Imperial College of Science and Technology, South Kensington, S.W.7.

B. Plant Breeding, Crop Varieties and Seeds.

H. Hunter, Esq., D.Sc.
Plant Breeding Institute, School of Agriculture, Cambridge.
Prof. R. G. Stapledon, C.B.E., M.A.
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Scottish Society for Research in Plant Breeding, Craigs House, Corstorphine, Edinburgh 12.
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Plant Breeding Research Division, Ministry of Agriculture for Northern Ireland, Stormont, Strandtown, Belfast.
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Seed Testing and Plant Disease Division, Ministry of Agriculture for Northern Ireland, Queen's University, Belfast.

C. Horticulture and Glasshouse Crops.

Prof. B. T. P. Barker, M.A.
Agricultural and Horticultural Research Station, Long Ashton, Bristol.
R. G. Hatton, Esq., C.B.E., M.A.
East Malling Research Station, East Malling, Kent.
D. Boyes, Esq., M.A.
Horticultural Research Station, School of Agriculture, Cambridge.
W. F. Bewley, Esq., C.B.E., D.Sc.
Experimental and Research Station, Cheshunt, Herts.
Sir A. D. Hall, K.C.B., M.A., LL.D., D.Sc., F.R.S.
John Innes Horticultural Institution, Mostyn Road, Merton Park, London, S.W.19.

D. Entomology and Plant Pathology.

J. C. F. Fryer, Esq., O.B.E., M.A.
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E. Agricultural Parasitology.

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F. Animal Pathology.

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G. Animal Nutrition and Breeding.

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H. Dairying.

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N. C. Wright, Esq., M.A., Ph.D.
Hannah Dairy Research Institute, Kirkhill, Ayr.
P. Clerkin, Esq., A.R.C.Sc.I., B.Agr.Sc.
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I. Agricultural Economics.

C. S. Orwin, Esq., M.A.
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Department of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh 2.

J. Preservation and Transport.

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Low Temperature Research Station, Cambridge.
C. West, Esq., M.A., M.Sc.
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Fruit and Vegetable Preservation Research Station, Campden, Glos.

K. Agricultural Engineering.

H. J. Denham, Esq., M.A., D.Sc.
Institute of Agricultural Engineering, Parks Road, Oxford.

II. ADVISORY CENTRES.

Prof. J. A. Hanley, Ph.D., A.R.C.S.
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Principal J. F. Rees, M.A., M.Com.
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